ENGINEERING CONSTRUCTION WEEKLY

ENGINEERING NEWS-RECORD

JANUARY 18, 1940

ANNUAL HIGHWAY NUMBER

Featuring: Roads for National Defense

The increased weight and speed of modern vehicles made this structure obsolete. Maintenance was an expensive problem because the plank flooring had to be replaced at frequent intervals.

Placement of a timber mat for bearing surface and erection of the Multi Plate units was done in winter without difficulty. Local unskilled labor using only hand tools completed the job in three weeks.

The new structure is situated upstream from the old bridge site. Three feet of fill covers the pipe and the slope is protected against erosion by a rip-rap headwall. The pipe was beveled to fit the slope for better appearance and hydraulic efficiency.

BRIDGE DOLLARS GO FARTHER

when you use Multi Plate

Limited funds need not stop you from replacing unsafe or inadequate bridges. Here's one example where the job was done with ARMCO Multi Plate at an estimated saving of 45 per cent over competitive material.

In this case relocation of the road, and the fact that the old structure was inadequate, dictated immediate construction. Unstable foundation conditions added to the problem. The solution, after making a bearing test, was an ARMCO Pipe on a timber mat. The 105-inch diameter pipe is 60 feet long and makes a sturdy, permanent installation that will last for years without maintenance.

You too can reduce costs and speed construction of large drainage openings by using ARMCO Multi Plate Pipe or Arches. Write us for complete information and prices. Armco Drainage Products Association, 501 Curtis Street, Middletown, Ohio.

MULTI ARMCO PLATE

ARMCO MULTI PLATE

A TYPE OF PRODUCT ORIGINATED AND DEVELOPED BY ARMCO ENGINEERS

ENGINEERING NEWS-RECORD

Devoted to Buildings, Sewers, Waterworks, Bridges, Highways, Streets, Dams, Foundations, Earthwork, Flood Control, Public Works, Irrigation, Canals, Railroads

Publication Office: 99-129 North Broadway, Albany, N. Y. • Editorial and Executive Offices: 330 West 42nd Street, New York

F. E. SCHMITT AND WALDO G. BOWMAN, *Editors* • ALBERT E. PAXTON, *Manager*

Vol. 124 *January* 18, 1940 No. 3

ANNUAL HIGHWAY NUMBER

Roads for Peace or War 77

National Defense Roads 79
War and the Inter-regional Highway Plan H. S. FAIRBANK 83
Loads and Roads for War and Peace LAWRENCE TUTTLE 86
Bridges Under Wartime Loads G. S. PAXSON 90

Highway Accomplishments, Budgets and Outlook 93

Roadbuilding in Money and Miles 94
Road Plans and Expenditures 97

A Quarter Century of Highway Progress 111

The Week's Events 65-122
Reader Comment 72
Editorials 74
Contract Unit Prices 120
New Aids to the Constructor 134
Construction Reports 183

THIS WEEK

How do war-service road requirements compare with commercial requirements? Anticipating that this question might logically be uppermost in the minds of highway engineers in war-ridden 1940, News-Record is devoting 16 pages of this issue to its answer.

In brief, the War Department and Public Roads Administration find it easy to cooperate because their requirements are much the same. PRA's interregional net and the Army's first priority system are similar in most details, and the mutual problem becomes principally one of improving surfaces, strengthening bridges and cleaning up other details. There are some exceptions, and these are reported here for the first time. A major conclusion is that metropolitan express roads, already badly needed for every day commercial and pleasure use, would become even more vital for industrial mobilization in time of war.

● Highway reports in January? It can't be done. But it has been through the splendid cooperation of 47 state highway engineers. In this issue, for the third consecutive year, these men have enabled *ENR* to bring its readers a first-of-the-year mileage and dollar report on highway department accomplishments for the year just closed, plus budgets for the year ahead. The excellent management and stability of highway finances is evident from the precision with which state highway engineers are able to forecast their programs. Last spring the close records of these officials enabled *Engineering News-Record* to predict that 1939 state highway expenditures would lag 2 per cent behind 1938. The 1939 expenditures reported in this issue, p. 93, are just 2 per cent below 1938. A 6 per cent gain is the mark for 1940.

● "A Quarter Century of Highway Progress" is an 8-page rotogravure primer of advance in highways and the machines which are used to make them. The lesson does not stop at showing the sunny side of highway work during the past 25 years; it goes on to point out glaring mistakes in practice which were made during the same period.

THINGS TO COME

RUBBER WATERSTOPS in dams are a recent development of considerable promise. In the Feb. 1 issue, the way the Bureau of Reclamation uses them will be described.

RENEWED INTEREST in ozone as a method of water sterilization has come with the recent development of a method for cutting the cost of such treatment. Results of test applications of the new method will be reported Feb. 1.

THE annual Review Number of Engineering News-Record will be published February 15.

An index for Vol. 123, July-December, 1939, will be bound in at the back of the Feb. 1 issue.

ENGINEERS WIN FIGHT AGAINST TIME

Bridge repair job rushed through with the aid of Atlas High-Early cement!

SPRING FLOODS washed out an abutment on a Boston & Albany railroad bridge near East Chatham, N. Y. Repairs had to be rushed through. But how could they get this new abutment—with a height above foundation of 28 ft., 17 ft. wide at the base, and 5-10 ft. at the top—ready to take the load in the shortest possible time?

Approximately 650 cu. yds. of Atlas High-Early strength concrete were placed in one continuous operation in this abutment in two days. Sufficient strength was developed at the end of one week to permit placing of load on the abutment. For Atlas High-Early cement gains strength several times faster than normal portland when used under the same conditions.

Rushing through repair or new construction jobs in record time is only one advantage of using Atlas High-Early cement. Here are others:

Atlas High-Early enables contractors to cut overhead costs and release equipment for other work. (Handy, too, in keeping clear of penalty clauses!) Also, forms may be struck earlier, so fewer sets of forms may be needed. And time required for protection and curing is reduced as much as 60% to 70%—saving time, cost, and promoting winter construction.

Analyze the cost and time factors on your next job. You, too, may be able to reduce costs, increase profits, and save time with Atlas High-Early cement. Universal Atlas Cement Co. (United States Steel Corporation Subsidiary), Chrysler Building, N. Y. C. NE-H-4

Abutment ready on time for B. & A. Railroad, at East Chatham, N.Y. Atlas High-Early cement used throughout. Contractor: J. F. Fitzgerald Construction Co., Boston. For size of abutment, compare with man at top.

Atlas High-Early Cement

A UNIVERSAL ATLAS PRODUCT

ENGINEERING NEWS-RECORD

NEWS

Volume 124 JANUARY 18, 1940 Number 3

Illinois Seeks More Water From the Great Lakes

Illinois has asked the Supreme Court to increase from 1,500 to 5,000 cfs the amount of water it can divert from the Great Lakes-St. Lawrence system. This is in addition to domestic pumpage and is sought "to avert the obnoxious, noisome, unhealthy and dangerous condition now existing in the Illinois waterway and the Chicago sanitary district canal."

The attorney-general of Illinois, in speaking of the increase which is desired until Dec. 31, 1942, stated that the increase "will not adversely affect present lake levels, as the water levels in the Great Lakes are now in the rising period of one of the fluctuating cycles."

Representatives of six Great Lakes states, namely, Wisconsin, Minnesota, Pennsylvania, Ohio, Michigan and New York, meeting in Detroit, Jan. 13 made known their opposition to such an increase, one representative at the meeting declaring that the increased diversion will be for the development of power rather than sanitation purposes.

• • •

No Negligence Seen In Grand Rapids Accident

The decision of a coroner's jury of six architects and engineers Jan. 12 stated that there was no evidence of "intent or criminal negligence" in the collapse of a recently poured section of a concrete roof for the city reservoir at Grand Rapids, Mich., which killed two workmen and injured seven others (*ENR*, Jan. 11, 1940, p. 57). Conjecture as to the cause of the accident eliminated cold weather in that the concrete was being poured at the time of the accident and since the walls and columns previously poured are sound and remained upright. Calculations of the supporting value of the falsework indicate that it was capable of supporting 2 to 2½ times the load imposed on it at the time of failure.

Labor Troubles Settled On Santee-Cooper Work

The dispute between organized labor and the McCarthy Improvement Co., Davenport, Ia., contractors on the $3,081,000 spillway dam of the Santee-Cooper project in South Carolina, has been settled after the start of construction had been delayed several weeks.

The fundamental issue in the dispute was alleged hiring of non-South Carolina labor while men were available through the union's employment service. Under terms of the settlement, the South Carolina Authority Trade and Labor Council of the American Federation of Labor will supply skilled and semi-skilled labor for the job and the South Carolina employment service the unskilled labor.

The strike against Wilbanks & Pierce, Inc., contractors for the North Santee dam, continues, but conferences looking toward settlement of this trouble are expected to be held during the next few days.

• • •

Toronto Citizens Favor $5,500,000 Building Job

Voting early this month, citizens of Toronto, Ont. approved the expenditure of about 5½ million dollars for the construction of a partial sewage treatment plant for the city of Toronto.

A corresponding vote on the proposed traffic amelioration plan, involving the same amount of money and construction of two new road connections, was not approved. The traffic plans were chiefly to benefit transit lines.

• • •

Pennsylvania Utility Plans $3,500,000 expansion

Metropolitan Edison Co., Reading, Pa., has announced a $3,500,000 expansion program which includes construction of the steam operated generating plant at Reading and improvements at Lebanon and West Reading stations.

Engineering Council Studies its Future

Possible changes in its organization discussed at 20th annual assembly held in Washington

Chief interest at the 20th annual assembly of American Engineering Council in Washington, Jan. 12-13, centered in the future status of the organization, the council having been brought to a crossroad in its progress by the resignation of its secretary, Frederick M. Feiker, and by uncertainty as to continued support from some of its member organizations. The council, made up of representatives from 8 national, 17 state and 29 local engineering organizations, gets its chief support from three national societies, the American Society of Civil Engineers, American Society of Mechanical Engineers, and American Institute of Electrical Engineers. Major uncertainty as to future financing arises from the fact that the American Society of Civil Engineers has had the subject of withdrawal from A.E.C. under discussion in its Board of Direction for sometime. A further financial complication has arisen through decisions of the Social Security

(*Continued on p. 66*)

• • •

Baltimore Housing Work Gets Court Approval

The Philadelphia Road housing project in Baltimore was upheld Jan. 10 when a judge of a circuit court ruled that the project does not "involve either a past or projected prospective, arbitrary or unreasonable action which suggests bad faith."

This was the fourth court decision on the question of the validity of the project, the main point at issue being whether the building of a housing project on vacant land should be considered as slum clearance housing. Litigation on the question was begun July 22 last.

Engineering Council

(*Continued from p. 65*)

Board and the Unemployment Tax Commission of the District of Columbia that A.E.C. must pay taxes to those two agencies totaling with penalties close to $6,000.

Originally the three founder societies contributed $1 per member to A.E.C., but that method of supporting the council was abandoned during the depression, the amount contributed by each society now being fixed by the administrative board of each society.

No formal action was taken on the subject of reorganization as a committee representing the Am. Soc. C.E., the Am. Soc. M.E. and the A.I.E.E. now is preparing a report on the organization and work of American Engineering Council. Edwin F. Wendt, reporting for council's committee on revision of the constitution, stated that his committee was withholding any recommendations until after the joint committee had submitted its report to the societies.

Fees discussed

An active discussion of fees paid by the U. S. Housing Administration followed a talk by A. C. Shire, technical director of that agency. Speaking for the civil engineers, George T. Seabury, urged that the USHA adhere to what the civil engineers had understood to be a verbal agreement by the USHA to segregate fees for structural engineering and foundation work just as it does for architectural work and mechanical work. These fees now are included with those for architectural services. Shire stated that he did not know what had become of that agreement, that he had accepted the recommendations of a committee representing architects and engineers, but that he was quite willing to reconsider the subject. He urged engineers to keep accurate cost records as the USHA fixes its fees for engineering and architectural services on the basis of actual costs. Its fees, he stated, can be adjusted if it can be shown that the present rates are not fair.

Mapping gains

J. S. Dodds, reporting for the committee on surveys and maps, stated that some encouraging results had been obtained as an outcome of the committee's activity in support of an adequate federal mapping program, but that the committee's objective still is far from being obtained. Dodds noted that in the budget now before Congress, the funds for survey work of the U. S. Coast and Geodetic Survey had been increased from $80,000 to $500,000 and that the U. S. Geological Survey had a similar increase from $725,000 to $1,970,000. The latter is about half what the committee has urged the Bureau of the Budget to provide for the U.S.G.S. in the initial years of an expanded program.

Federal public works

Alonzo J. Hammond, chairman of the committee on public works, reported on activities of A.E.C. looking toward the establishment of a federal department of public works and noted that a start in that direction has now been made through the creation of the Federal Works Agency. Hammond urged that the council continue its campaign for a still more comprehensive department headed by an officer of cabinet rank.

At one of the luncheon meetings, John M. Carmody, head of the FWA, told of its development to date. He said that those in charge of the agency are going slow in making radical changes and added that suggestions as to how the FWA might be developed to produce the greatest efficiency would be welcomed.

New officers

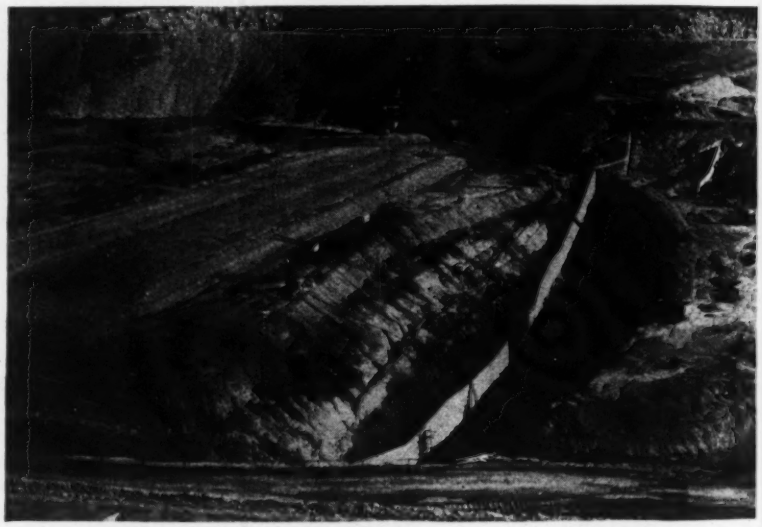
Alonzo J. Hammond, consulting engineer, Chicago, was elected president for a two-year term, succeeding William McClellan, of St. Louis. New vice-presidents are W. L. Batt and Donald A. Sawyer. L. J. Fletcher was re-elected treasurer. Frederick M. Feiker was renamed executive secretary to serve until his successor is chosen.

BRIEF NEWS

ENGINEERS of the Shell Oil Co. estimate that damages to the 40 mi. of pipeline torn up from a point in Archer County, Tex., to near Ryan, Okla. by the explosion of Dec. 15, total $350,000. The explosion occurred when an oxygen test was being run, preparatory to the start of oil transportation.

WITH DEPLETION of New York City's water supply reservoirs continuing despite rains of this week, chlorinated river water is being used for street flushing to conserve drinking water.

UNDER a new policy of performing all possible trunk highway work by open, competitive contract instead of under a "maintenance betterment"



WORK PROGRESSES ON DEER CREEK DAM IN UTAH

WORK is well advanced on Deer Creek Dam being built by the U. S. Reclamation Service for the Provo River Water Users Operating Agency, at a cost of $2,190,000. The Rohl Connolly Co., Los Angeles, Calif., represented on the job by O. C. Stevens, is the general contractor.

The dam, which is now 50 per cent complete, will be 240 ft. above bedrock, 150 ft. above stream bed, and 150,000 acre-ft. in capacity when completed.

To supply the Metropolitan Water District of Salt Lake City with 46,000 acre-ft. of water a year from Deer Creek Dam, the Salt Lake Valley conduit is being built by the Reclamation Service, the cost of this work being $5,450,000. The George K. Thompson Co., Los Angeles, Calif., holds the contract for the Olmstead tunnel section and for the Alpine-Draper tunnel section. The Utah Concrete Pipe Co., Salt Lake city, is the contractor for a section 7 8/10 mi. in length. Other contracts will be awarded later to complete the conduit, which is to be 150 cfs in capacity.

day-labor system formerly used extensively in the past, the Minnesota State Highway Department expects to have more than $5,000,000 in federal aid available this year as compared to $3,514,000 in 1938 and $3,785,000 in 1939, according to M. J. Hoffman, state highway commissioner.

. . .

Construction Lumber Firms Consolidate at Chicago

A. Fletcher Marsh, president Marsh & Truman Lumber Co. has announced the consolidated of his company and the J. O. Nessen Co., wholesale interests of two pioneer Chicago lumber firms serving railroads, waterways and heavy construction. Operations will continue under the name of Marsh & Truman Lumber Co. J. O. Nessen, a pioneer of Manistee, Mich., incorporated his concern in Chicago in 1910. His was the last company operating lumber schooners on the Great Lakes moving its activity to the south just prior to the War.

The other company now approaching its fourth generation in the lumber business was founded in 1864 and operated in the great oak producing territory of northern Indiana and southern Michigan. It followed the white pine industry to its end but in 1886 went south for the then unknown longleaf yellow pine for the Marshall Field wholesale building. Some of the timbers are still used on fence around the same site, now a parking lot. This firm brought the first fir into the Middle West about the time of first Chicago Worlds Fair.

Wide World Photo

A SHIELD STARTS ACROSS CHICAGO'S LOOP

THE FIRST SHIELD ever used on a major tunnel project in Chicago started on a 4,200-ft. journey across the Loop last month on S. A. Healy's State St. subway job. Another shield will follow close alongside to drive the second of the twin tubes required.

The shield is 25-ft. in diameter, and will operate under compressed air. Primary lining will be structural steel segments, 33 in. wide. More than half of the State St. section will be for a station incorporating a center platform.

Shield tunneling was specified for both the Dearborn and State St. sections in the Loop because of the neighboring high buildings on floating foundations.

S. A. Healy has the contract for both sections.

Reclamation Contract Upheld by Court

U. S. Court of Claims rules against MWAK, builder of Grand Coulee low dam

Provisions in the standard construction contract of the Bureau of Reclamation which, in effect, prohibit a contractor from appealing to the courts on disputed questions were upheld last week by the U.S. Court of Claims. The case was brought by the contractors for the low dam at Grand Coulee in an effort to obtain extra compensation for work done on the dam, but the court denied the claim. The contractors, a syndicate made up of Silas Mason Co., Walsh Construction Co., and Atkinson-Kier Co., asked $5,260,000 for work which, it was asserted, was ordered by the government's contracting officer and not satisfactorily paid for. The original construction contract was for $29,339,000, and an additional $10,000,000 has already been paid for extra work arising from the decision to construct the dam as a base for the high dam now under construction rather than as a low dam.

The construction contract contained a provision requiring that the contractor protest in writing within 30 days against any decision or order of the contracting officer which he regards as unfair; it also stipulates that the contractor may appeal to the Secretary of the Interior on disputed points and that the Secretary's decision shall be final.

MWAK admitted that it did not follow this procedure in the disputes on which the court has now ruled, but characterized the provisions as "vicious" in that they "increase departmental power over the contractor and place the exercise of the power . . . beyond the power of the courts," depriving the contractor of fundamental rights.

This interpretation, the court ruled, was too broad, since the contracting officer's decisions could be overruled by the courts if obviously arbitrary or negligent. The ruling pointed out that although MWAK made a general charge of arbitrary and negligent action, this was nowhere demonstrated in a specific case.

"The contract," the court held, "is a harsh one but its language is perfectly clear and we cannot reform it."

Holding that the disputed provisions are valid and enforceable, and that in any case the contractor had failed to exhaust the remedies provided by the contract, the court dismissed the claim.

Attorneys for the contractors indicated they would file a new claim in the court of claims, setting forth the facts in detail to meet court objections.

WASHINGTON HIGHLIGHTS

Special reports by Paul Wooton

CLAIMING that their anti-trust investigations of the building industry are already repaying their cost many times over, Department of Justice officials point to the award last week of the contract for USHA's Terrace Village No. 2 in Pittsburgh at $5,381,000—about $1,300,000 less than the architects estimate. They assert that this is a result of the concentration of anti-trust activity in Pittsburgh and point out that the saving on this one project is almost exactly equal to the total appropriation for anti-trust activity in the current fiscal year. Justice officials are especially gratified that the budget recommends only $100,000 less for anti-trust this year than next since they conceive their job in the building field as one of continuous policing rather than once and for all to eliminate combinations.

ALTHOUGH the President's budget message recommended that cost of maintaining waterways and navigation services (about $50,000,000) be met by fees from users, the bill to that end which Rep. J. B. Snyder introduced last week is unlikely to be the one that will be approved. Snyder would charge a cent per ton for each lock passed, which, considering there are more than 40 locks on the Ohio, might be rather high. The administration is believed to be thinking in terms of a small charge per ton-mile.

ORIGIN OF THE ALLEGED PLOT to blow up Boulder Dam may be clarified if Congress acts on a resolution introduced this week directing the Secretary of State to produce any information he has. Recurring newspaper reports of a plot have been attributed first to Reclamation (*ENR*, Dec. 14, 1939, p. 797) and more recently to the Federal Bureau of Investigation and the State Department. Commissioner of Reclamation Page states that no evidence of sabotage has ever been found and that no precautions have been taken except those required to handle the increased number of visitors and to protect navigation on Lake Mead from the suction at the intake towers. Anyway, the commissioner says, it would be pretty hard to hurt the dam.

HIGHWAY ORGANIZATIONS are united in wanting to see the pending federal aid authorization bill increase federal aid from the present $110,000,000 at least to $125,000,000 in fiscal 1942 and 1943. Opinion on the new Title II, providing loans for rights of way, is divided, however. The Associated General Contractors of America is on record in its favor and is supporting it enthusiastically.

• • •

New Mexico Wage Boosts End Highway Controversy

A new wage scale boosting the rate for average skilled and semi-skilled labor 10½ cents an hour ends the long controversy (*ENR*, Nov. 2, 1939, p. 592) in New Mexico over minimum pay for state highway work and clears the way for letting of a dozen projects. The scale is very much the same as that proposed by the state labor commission Dec. 1, or the scale recommended as a compromise after the highway department refused a "union scale."

With the new rate there is an increase in pay for ten classifications of work and common labor will continue at a flat 40 cents an hour. The increases, which are as much as 25 per cent for some classifications, have been approved by the Public Roads Administration.

Building Probe Continues In Chicago, New Orleans

The federal grand jury investigation of the building industry continued this week with the indictment of 41 in the tile trade at Chicago and 44 AFL men at New Orleans. Along with those named on charges of conspiracy to restrain trade in violation of the Sherman Anti-trust laws at Chicago were 14 corporations, a trade association, a union and 25 individuals.

Those named in the New Orleans indictments included the Building and Construction Trades Council and most of the city's AFL building trade unions and their officials. All indicted in New Orleans were charged with refusing to receive material delivered by the United Transport Workers Union, which is affiliated with the CIO.

Last week 25 defendants, including the local chapter of the National Electrical Contractors Association, were fined in New Orleans. The association was required to pay $3,500 and each of the individuals $100.

Total indictments for the entire nation since the Department of Justice began its drive in October of last year now numbers approximately four hundred.

LONGEST GRADE SEPARATION SUBWAY IN CHICAGO OPENED

THE AUSTIN AV. $1,210,000 underpass, longest in Chicago, was opened Jan. 4. It extends for 620 ft. under 44 railroad tracks of the Galewood Yards of the Chicago, Milwaukee & St. Paul R. R. from Dickens St. to Cortland St.; approaches increase the length to 1,600 ft.

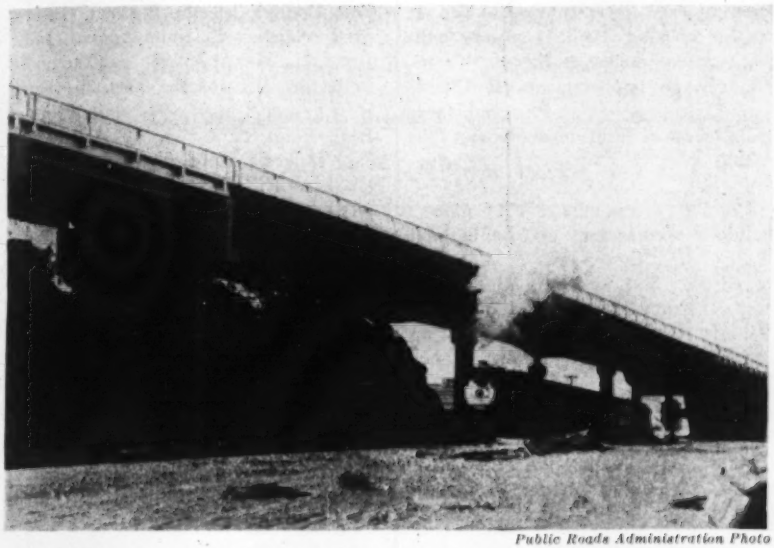
Abutments are of the box type. The ballasted steel deck is welded plates on stringers, waterproofed with three layers of membrane and 1½ in. of bituminous armor cast-molded over the membranes. A 44-ft. roadway is laid on the 66-ft. street. The peculiar rectangular light in the center is due to a light and ventilating shaft. The square spots above the arches are soffat refractory light designed to eliminate glare in the eyes of the automobilist.

This subway is one of six grade separation projects totalling $5,200,000 recently completed or under construction in Chicago. All of the projects were partly financed by federal grants and are sponsored and built under the supervision of the board of local improvements for which Arthur Engh is engineer of special improvements.

New Orleans AGC Chapter Fined in PWA Inquiry

Jan. 15 at New Orleans the local chapter of the Associated General Contractors of America was fined $2,000 and three construction firms and eleven individuals $200 each by a federal judge on the charge of diverting PWA funds. The fines were imposed after a federal grand jury had investigated bidding on the Charity Hospital foundation (*ENR*, Dec. 7, 1939, p. 737).

It was alleged that the R. P. Farnsworth Co., which received the contract, paid $8,000 to the association chapter, which in turn gave $840 to each of the unsuccessful bidders. In addition, it was claimed that all bidders for the work had added the estimating and other expenses of competitors to their bids.



Public Roads Administration Photo

GRADE SEPARATION VIADUCT COMPLETED AT GREYBULL, WYO.

A GRADE SEPARATION VIADUCT has been completed over the two tracks of the Chicago, Burlington and Quincy R.R. at Greybull, Wyo., on U. S. Highway No. 20, commonly known as the Yellowstone Highway. The new viaduct replaces an old structure built in 1920, and eliminates all traffic congestion on the highway, which previously followed the main business street of Greybull to make four right angle turns within the town limits.

The new structure, designed for the standard H-15 loading, is 538 ft. long and consists of three 96-ft. continuous steel deck-plate girder spans, and six 40-ft. rolled beam spans. A reinforced concrete deck provides a 30-ft. roadway and one 4½-ft. sidewalk. Since the angle of the skew between the center line of the viaduct and the railroad tracks was only 13 deg., 13 min., it was necessary to spread the columns for two of the central bents of the viaduct to accommodate the two tracks, which are spaced at a distance of 21½ ft. center to center.

To protect the tracks at the north end, a 110-ft. retaining wall was necessary. This abutment, the retaining wall and the first structure bent adjoining were built on driven precast reinforced concrete piles averaging 22 ft. in length and designed for a maximum load of 29 tons each. All remaining substructure footings are founded on good hard sandstone.

The deck of the viaduct was constructed to fit an 800-ft. vertical curve having end-tangent grades of 6 and 1.5 per cent, respectively. The south 224 ft. of the deck also forms a 2-deg., 30-min. horizontal curve, this portion of the highway involving four of the 40-ft. spans and one of the 96-ft. spans.

Edward Selander, Greeley, Colo., was the general contractor, the structure proper costing $101,200, and the approaches $33,500. The work was done by the Wyoming State Highway Department under the direction of Frank Kelso, superintendent. Plans were prepared by W. H. Fisher, the department's bridge engineer; J. R. Bromley, resident engineer, aided by R. C. Pike as project engineer, supervised construction. H. A. Aalberg, assistant chief engineer of the Lincoln Division, and E. L. Haley, resident engineer at Casper, Wyo., represented the railroad. B. W. Matteson, district engineer of the Denver office, represented the Public Roads Administration.

All funds for plans and construction were supplied by the federal government through the 1938 allotments for grade separation work.

Shore Protection and Development Studied

American Shore and Beach Preservation Association Holds Annual Meeting in Washington

Public beach development plans and shore protection progress reveal increasing appreciation of shore values, according to the discussions at the annual meeting of the American Shore and Beach Preservation Association at Washington last week. Prominent illustrations of this appreciation were a plea by Conrad L. Wirth of the National Park Service for public ownership of 10 per cent of the shore frontage and by A. A. LaFountain of the New Jersey Board of Commerce and Navigation for preservation of that state's plan to establish six public beach developments. A program of cooperation among states, the federal government and other interests in the construction of protective works was proposed to the meeting and was referred to a special committee of the association with a view to developing suitable legislative plans if found acceptable.

Beach work reviewed

Reviewing the activities of the Beach Erosion Board, established just ten years ago, Gen. Thomas M. Robins, Assistant Chief of Engineers, U. S. Army, and Col. J. J. Bain, chairman of the board, outlined its decade of work, beginning with field studies of shore currents and sand movements and the protective effect of bulkheads and groins. Following the field study, laboratory work and model experiments were carried on in a small wave tank, and later the present larger wave tank was built at Dalecarlia, where a program of fundamental research is under way. To date 22 beach erosion studies have been carried out in cooperation with states and municipalities; 13 others are under way. Works conforming to recommendations of the board have been built at a number of points, and at Wrightsville Beach, N. C., the ocean has been pushed back fully 300 ft. by such works, said Colonel Bain.

Gratifying results

Ten years' progress in shore protection was reviewed by F. E. Schmitt, editor, *Engineering News-Record*. Gratifying results have been achieved in research and field study, he said, but progress in actual construction of protective works has been nearly zero. This condition is mainly due to the confusion of overlapping interests and authority along the shore, "a twilight zone of rights and jurisdictions." As a

(*Continued on p. 71*)

OBITUARY

OWEN A. WAITE, 65, for the past two and one-half years chief hydrographer of the Los Angeles County Flood Control District, died Jan. 10. Prior to his employment in the flood control district, Waite had spent 22 years with the Southern California Edison Co., most of the time having been spent as chief hydrographer.

JOHN B. DOWER, 74, retired railroad and highway contractor, died Dec. 31 at Ballston Springs, N. Y. For the past several years, following his retirement from the contracting business, Dower had been supervisor of WPA activities at Milton.

F. A. MACDONALD, retired engineer of Emmet County, Iowa, died at Estherville, Iowa, Jan. 7. MacDonald, who supervised much of the construction of the old Burlington, Cedar Rapids & Northern Ry., now part of the Rock Island R. R., was county engineer for 25 years.

PAUL HOOKER, 65, for the past 21 years connected with the Hooker Electro-Chemical Co. of Niagara Falls, N. Y., died in that city Jan. 11. Hooker, a graduate of the University of Rochester, aided in the construction of the water filtration plant at Harrisburg, Pa., and was associated with the construction of sanitary works at Lynchburg and Steelton, Va.

GEORGE E. TROUT, 82, veteran waterworks engineer at Tiffin, Ohio, died in that city Jan. 8. Trout retired 11 years ago as engineer of Tiffin's waterworks system after 38 years of service.

RAYMOND J. BEAUSOLEIL, 53, vice-president and general manager of the National Supply Co. at Montreal and a civil engineer specializing in industrial heating plants, died in Montreal Jan. 11. Beausoleil, after graduation from l'Ecole Polytechnique, was employed by the Delaware & Hudson R. R. at Scranton, Pa., and later by the Montreal Harbor Commission.

JOSEPH NEVIN, 88, road contractor and for ten years a supervisor of the Kentucky State Highway Department, died Jan. 8 in Louisville, Ky. Nevin, a former head of the Louisville Brick Co., was a member of the first Louisville board of public works in 1895.

WALLACE D. WYETH, JR., 28, assistant inspector for U. S. Engineers, died last week in Greenville, Miss. He had been connected with the army engineers for several years.

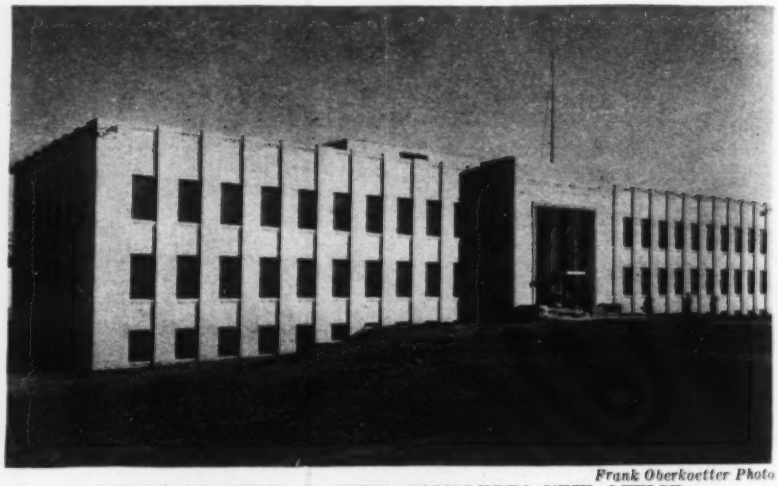
S. J. ZOWSKI, 59, former professor of hydraulic engineering at the University of Michigan for 16 years, and one of the men engaged in the reconstruction of Poland after the World War, died Jan. 11 in Charleston, S. C. Zowski, who served as adviser to President Wilson on the Treaty of Versailles, taught several years at the Warsaw Polytechnic Institute.

RUSSELL H. FOLWELL, president of R. H. Folwell Engineering Co., contractors, died recently in Chicago at the age of 69. Folwell's company built the terminal docks at Newport News, Va., sewage improvements at Cincinnati, Ohio, and Erie, Pa., and large grain elevators in Minneapolis and Port Arthur.

DONALD CAMPBELL, 96, pioneer building contractor of Bellingham, Wash., died there Jan. 5. Campbell paved the first street in Bellingham and constructed the first buildings at Western Washington College of Education.

JOHN CARLIN, 51, president of the contracting firm of Granfield, Farrar and Carlin, died in Red Bluff, Calif., Jan. 9. Early in life Carlin entered the construction field and was one of the pioneer contractors who helped rebuild San Francisco after the earthquake and fire of 1906. At the time of his death he was supervising grading work on the relocation of the Southern Pacific line around Shasta Reservoir.

Other recent deaths include: CHARLES F. WOODLING, SR., 61, retired building contractor, Kansas City, Mo.; STEWART W. JAMESON, 68, structural engineer, Duluth, Minn.; CHARLES MCCULLOCK, 42, construction superintendent on a job at Fort Dodge, Iowa, Fort Dodge; JOSEPH SERTELL, 75, retired contractor, Indianapolis, Ind.; JOHN C. MATHEW, 68, contractor of Belleville, Ill., for the past 35 years; R. LUTHER GREEN, 69, contractor of High Point, N. C.; J. A. MCDOWELL, 79, retired builder, Globe, Ariz.; CHARLES H. HART, 72, retired civil engineer, New Rochelle, N. Y.; LEON BURGHART, 57, for 12 years an engineer-inspector for the Yonkers, N. Y., department of public works and former contractor; J. H. L. BROOKS, 63, engineer with the U. S. Engineers, Bloomington, Ill.; N. H. SHEPPARD, 71, retired building contractor of Pierre, S. D.; HARRY H. BELL, 89, retired building contractor of Seattle, Wash.; RAY BURRILL, highway superintendent of Faulk County, N. D., Aberdeen, N. D.; BENJAMIN F. SPIRE, 71, paving contractor of Buffalo, N. Y.



Frank Oberkoetter Photo

KEYSTONE STEEL & WIRE COMPLETES NEW OFFICE

THE KEYSTONE STEEL & WIRE CO., Peoria, Ill., Jan. 5, held open house in its new 207 x 58 ft. three-story office building. Albert Kahn, Inc., architects and engineers of Detroit were responsible for the design of the new structure, which is of reinforced concrete column, slab and beam construction with exterior bearing walls and piers of light buff face brick, harmonizing with the limestone portico.

Direct radiation, employing a 2-pipe system, provides heat throughout the building. The heat is thermostatically controlled in the executive offices. A complete air conditioning system is installed, using a combination of well water and machine type operation. The offices are uniformly lighted to an intensity of 20 foot-candles by a system of indirect Mazda lighting, current being transmitted through underground conduits from the company's plant substation.

Engineer Reclassification Begun in New York City

Reclassification of engineers and architects in civil service in New York City has been begun by the municipal civil service commission as the result of a long study in which the engineering organizations of the City participated. Under the plan adopted by the commission and approved by the mayor, some 500 varied frequently overlapping classifications are to be reduced to 50 basic titles with corresponding salaries and responsibilities.

Minneapolis Water Plant To Cost $3,880,000

The water softening plant, being built at Minneapolis and originally estimated in 1935 by water department engineers, to cost between $1,290,000. $1,560,000 will come closer to $3,880,000, according to J. A. Jensen, water department engineer, and E. W. Johnson, construction engineer. The plant was originally planned as a PWA project but in order to start the work earlier, construction was started in 1936 and has been handled by force accounts.

Fast Tunneling Record On Delaware Aqueduct

Fred Stiefel, chief engineer for Samuel R. Rosoff, Ltd., on Contract 313 of the Delaware River aqueduct, claims a world's record of some kind in driving 1,718 ft. of 18-ft. tunnel in two headings from Shaft 4 in December (6-day weeks). The ground was hard rock, but had to be supported with steel timbering carried right to the face. Maximum weekly progress was 213 ft. in heading 3 north and 210 ft. in 3 south. Methane gas is causing considerable trouble at Shaft 3.

A search of *ENR* files fails to produce any better tunnel records for timbered hard-rock ground. Utah Construction Co. drove 1,027 ft. from one heading in one month on the Iron Mtn. tunnel of the Colorado River aqueduct, through cemented gravel that required heavy timbering.

However, for real fast driving on the Delaware River job, Stiefel merely has to look down the mountain to the south, where Wm. Durkin drove 2,398 ft. in two headings from Shaft 4 last month for Walsh Const. Co. The ground is a hard shale that requires no timbering, and Durkin has been accused of wasting powder for "using more than a dozen 12-ga. shotgun shells per round." Maximum weekly progress at Shaft 4 was 295 ft. in the north heading and 294 ft. in the south heading. Durkin has reached 62 ft. daily progress in single headings three times in the past month, and 114 ft. in two headings from one shaft.

What is believed to be the world's record for hard-rock, untimbered ground was established last October when 1,534 ft. was driven from one heading on the Carlton Drainage Tunnel in Colorado.

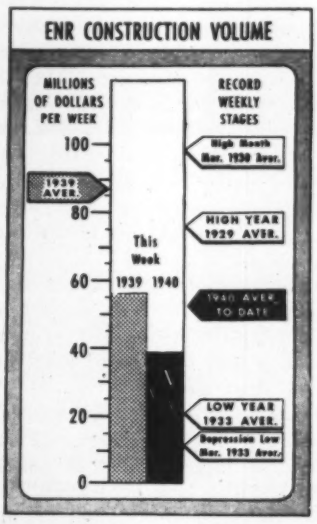
CONTRACTS AND CAPITAL

ENGINEERING construction awards for the week total $41,461,000, a decrease of 36 per cent from a week ago, and 25 per cent below the volume for the corresponding 1939 week.

The week's awards bring 1940 construction to $159,299,000, a level 39 per cent lower than the total for the 3-week period last year when the volume was swelled by the rush to get PWA projects under contract. Private construction for the three-week period in 1940 is 27 per cent higher than in the corresponding period a year ago.

Private awards for the week, however, are 30 per cent below a week ago and 36 per cent below a year ago. Public construction is 37 and 21 per cent lower, respectively, than last week and last year.

Industrial buildings and bridges are above their respective totals for the preceding week and the 1939 week. They are the only classes of construction to top their volumes of a week ago and a year ago.



New capital for construction purposes for the week totals $6,523,000, a decrease of 71 per cent from the volume reported for the corresponding 1939 week. The current week's new financing is made up of $4,914,000 in state and municipal bonds, and $1,609,000 in corporate security issues.

Despite the decline in the week's new construction financing, the total for the year to date, $68,933,000, is 19 per cent higher than the total for the 3-week period last year.

CONTRACTS

(Thousands of dollars)

	Week Ending Jan. 19 1939	Jan. 11 1940	Jan. 18 1940
Federal	$3,369	$8,402	$3,169
State & Municipal	35,255	40,385	27,440
Total public	$38,624	$48,787	$30,609
Total private	16,865	15,591	10,852
TOTALS	$55,489	$64,378	$41,461
Cumulative 1940 (3 weeks)			$159,299
Cumulative 1939 (3 weeks)			$262,210

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial building, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1939 3 Wks.	1940 3 Wks.
NON-FEDERAL	$57,654	$68,933
Corp. securities	17,645	9,854
State & Mun.	31,971	13,880
R.E.A. loans	8,038	....
U.S.H.A. loans	....	45,199
FEDERAL	$....	$....
TOTAL CAPITAL	$57,654	$68,933

FHA MORTGAGES

	Week Ending Jan. 14 1939	Jan. 6 1940	Jan. 13 1940
Selected for appraisal	$16,858	$14,153	$15,244*
Cumulative 1940 (2 weeks)			$29,397*
Cumulative 1939 (2 weeks)			$30,427

* Subject to revision.

ENR INDEX NUMBERS

Index Base = 100		1913	1926
Construction Cost	Jan., '40	238.34	114.57
Building Cost	Jan., '40	201.52	108.94
Volume	Dec., '39	172	75

Shore Protection

(Continued from p. 69)

remedy he proposed cooperation of shore interests under federal leadership, including federal conduct of a continuing program of observations and surveys, and federal aid in planning and construction.

J. Spencer Smith, president of the association, touched the same problem in his presidential address, saying that a major element of the difficulties in the way of shore protection is the fact that most of those who use the shore are not owners or residents. Discussion of Schmitt's paper led to adoption of a resolution to refer it to a special committee, to report recommendations at the next meeting.

Directors and officers of the association were reelected.

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

More on Beam Deflection

Sir: Beam deflection is continually being brought to notice. The past ten years have been specially prolific in literature on the subject. *Engineering News-Record* found space in its columns for six contributions from as many writers during the six months ending June 1, 1937.

The writer in retrospect turns to his college days of more than sixty years ago when the double integration method was almost the only method taught. In his opinion this method should still be thoroughly understood by the structural engineer. As Professor Swain says in his "Strength of Materials" (1924), the equation of the elastic line,

$$\frac{d^2y}{dx^2} = \frac{M}{EI}$$

is the starting point of all analytical investigations of slope and deflection due to normal stresses alone.

Professor Boyd gives as one reason for the deflection of beams receiving what some might consider undue prominence in his "Strength of Materials" (4th Edition, 1935), that in proportioning statically indeterminate beams, "external reactions and moments, which are necessary for the calculation of stress, may be found only by means of deflection formulas".

Professor Grinter in the preface of his book, "Statically Indeterminate Structures and Space Frames" (1937), states that "any attempt to teach indeterminate structural analysis to a student who is inadequately grounded in the theory of deflection computations or who lacks the ability to visualize deflections and rotations is quite as hopeless as an attempt to teach truss analysis to a student who does not understand the equations of statics". In Chapter 3, "Deflections of Structures", he writes: "The method of internal work is widely accepted as the most satisfactory method of determining the deflection of *any point* on a body in *any direction* caused by *all possible kinds of internal distortions*."

Other methods are preferred by some. In fact, the structural engineer can run riot in determining beam deflection. Eighteen or twenty methods have been listed by me. Some of them, however, are deviations of other methods and not distinct in themselves. The "best method" for an engineer in active practice is the one with which he is best acquainted.

The hope, perhaps rather a wish, is that a book be brought out devoted exclusively to beam deflection. This wish was expressed by me a few years ago (*Civil Engineering*, Vol. 5, p. 638, October 1935) and ably seconded (*Civil Engineering*, Vol. 6, p. 43, January 1936). The wish has become a greater need now than then. The material for such a volume lies scattered in scores of textbooks and innumerable articles in the technical press. A wise selection arranged with uniform notation throughout would be of interest to the structural engineer, especially so to an instructor of the subject.

ROBINS FLEMING
Structural Engineer (Retired)
New York, N. Y.

California Water Supplies

Sir: Our attention has been called to an error in the printing of the number of "driven and bored wells" as reported for California in the *Inventory of Water Supply Facilities* published in *ENR*, Sept. 28, 1939, p. 414. The number should be 205 and not 25 as was originally given in the data we furnished.

C. G. GILLESPIE,
Chief, Bureau of Sanitary Engineering

Emergency Contracts

Sir: Having read with considerable interest the editorial on p. 459 of the Oct. 12 issue of *Engineering News-Record*, and agreeing with you in your viewpoint, I am writing to call to your attention a form of contract used by some railroads which I have never seen, but which I am told works somewhat in the following fashion.

The contract is awarded on a percentage basis which is quoted by the contractor with a guaranteed cost. In his bid the contractor mentions the unit prices used in preparing the bid and anticipated profit. In the event the final cost runs under this amount after providing for the profit, the saving is split between the railroad and the contractor. In the event the final cost runs over the amount, I understand it digs into the contractor's anticipated profit but never leaves him a loser on the job; but he might have to do the job at no profit. I further understand that it also provides for additions or deductions to quoted unit prices as current conditions might warrant.

A digest of this form of contract would be of interest to me.

R. E. ARCHIBALD
E. L. Archibald Co.
Chicago, Ill.

Engineer Interneships

Sir: Advocated by students and viewed with keen interest, is a relatively new system of engineering interneships recently given a trial in a department of New York City. The title of "cadet engineer" was sanctioned by the state civil service commission in the Department of Public Works. The plan is part of a new program in conjunction with the civil service in the various fields of engineering.

It would provide a means for enabling the engineering student to obtain experience, at the same time gaining first hand valuable working knowledge and furthering his chances for advancement. Following a similar method employed in medical interneships, it would undoubtedly prove of great beneficial value to students desiring to enter the engineering profession.

In the city department, the "cadets" are assigned to numerous subdivisions, such as bridge construction and sewage construction. The interneships are for a one-year period. After their year is concluded, the students receive no special treatment from the civil service commission as far as exams are concerned. However, their year of interneship will be acceptable for credit in experience in higher civil service examinations for engineer.

Assuming the system will eventually branch into other city, state and federal departments, it would enliven the ambition of many students and would provide a source of outlet for the large amount of college graduates who lack experience. The period of interneship would provide

a basis for claim to such experience in civil service as well as in private enterprise.

This program has long been advocated by instructors and teachers in leading schools and by public officials. Young engineering graduates are sometimes afraid or skeptical of their abilities and fear responsible jobs. Under this procedure, they would advance upon stages and gain their own confidence. It is hoped that more local and state governments will adopt measures to following this program.

JACK ROYAL PARKER
Technical Society
Columbia University
New York

Sales Engineers

Sir: If—"An engineer is a man who knows a great deal about a very little, and who goes along knowing more and more about less and less until finally he knows practically everything about nothing;"

And—"Whereas, on the other hand, a salesman is a man who knows very little about a great deal, and keeps knowing less and less about more and more until finally he knows practically nothing about everything;"

Then—What I want to know: Where does a sales-engineer come in?

R. A. BENNITT
Hillsdale, N. J.

In Defense of Engineers

Sir: In your issue of January 4, 1940, page 33, I. E. Morris of Birmingham, Ala., unburdens himself of some rather unhappy reflections on the ethics of the engineering profession.

In my long experience as an engineer it has been my good fortune to have met, in public office or private trust, very, very few engineers who "pounce upon the errors of his fellow engineers." Only at the sternest call of duty or in the cause of public safety have I ever heard a *real* engineer adversely comment on the work of another engineer. Instead, what I have met has been men who are earnest seekers after truth; who have shown fine cooperation and loyalty to their jobs with that *esprit de corps* which made them willing, in pursuit of their objectives, to work and live under conditions, sometimes fit "only for rats and engineers."

When the engineer is, as Mr. Morris states, "inarticulate," it is often due to an inquiring mind, ever open to the possibility of error in the offing and the desire to be sure, very sure, that what he has to say will "hold water." This latter characteristic is sometimes lacking in the "good showmanship" which, to Mr. Morris's evident regret, is not very common.

"The optimist sees the doughnut, the pessimist sees the hole."

JOSEPH KEMPER
Civil Engineer
Utica, N. Y.

"Aseismic" Wrongly Used

Sir: I have noted in technical articles on the subject of earthquake-resistant design and construction an increasing use by the authors of the term "aseismic"; for example, "Cost of Aseismic Construction", "Reinforced Concrete in Aseismic Design", "Aseismic Design of Wood Structures", etc. From the context it is evident that they mean design or construction made secure against earthquake, or earthquake-resistant. It is to be noted, however, that the word "aseismic", according to Webster's Dictionary means "not subject to earthquakes, as an aseismic region". The adjective that should have been used is "aseismatic" which, again quoting Webster, means "not seismatic, secured or securing against earthquake shocks"; or the simpler adjective "earthquake - resistant" would have been sufficient.

HENRY D. DEWELL
Consulting Engineer
San Francisco

Paving at Intersections

Sir: I have read thru the November 23, 1939, issue of *Engineering News-Record* and would like to call your attention to a typographical error in the article titled "Paving Areas at Intersections" on page 71 (Vol. p. 711), which was submitted by Verlin M. Wann, State Highway Department, Indianapolis, Ind.

The designation for the area referred to in the second formula should be *DCOBD* instead of *DCDB* as shown.

Mr. Verlin's table is set up for skew angles in even degrees between 0 and 75 deg. inclusive. There are times when it is desirable to compute to minutes or a greater degree of accuracy. For such cases the formula for obtaining area A_2 is not shown and is important since the skew angle is subtracted from 90 deg. instead of adding as for area A_1.

The formula for obtaining area A_2 is as follows:—

$$A_2 = R_2^2 \tan\left(\frac{90^\circ - \theta}{2}\right) - \pi R_2^2 \left(\frac{90^\circ - \theta}{360}\right)$$

The table shown in the above article is satisfactory for even degrees between 0 and 75 deg.; however, for skew angles greater than 75 deg. and for angles in minutes and seconds it is necessary to use the formulae for A_1, A_2 and A_3.

ROBERT R. ALUISE
Pennsylvania Turnpike Commission
Everett, Pa.

Hollow Concrete Girders On Waterloo Bridge

Sir: In your issue of Dec. 21, 1939, p. 31, you are in error in stating that the new Waterloo Bridge across the Thames at London consists of five 250-ft. reinforced concrete arches.

These are 250-ft. spans but they are box-girders, not arches. *Concrete and Constructional Engineering*, January, 1939, p. 51, describes the spans as "cellular reinforced concrete boxes". They are supported on narrow, slender "bearing walls" which stand free in the center of granite-faced piers. There is no provision made to develop or resist horizontal thrusts of arch magnitude at the piers or abutments.

That such spans in reinforced concrete with box-girders are quite feasible is further attested by the 230-ft. span across the Marne at Bry, France, briefly described in *The Engineer*, July 28, 1939, p. 100.

Le Génie Civil, July 1, 1939, p. 1, describes the new reinforced concrete box-girder bridge across the Seine near Paris at Villeneuve-St.-Georges. The central span is 256 ft.

H. M. HADLEY
Regional Structural Engineer
Portland Cement Association
Seattle, Wash.

Big Concrete Pipe

The caption on the picture of the large concrete pipe being used in the Boston Quabbin Dam project (*ENR*, Nov. 23, 1939, p. 673) contained an error. These pipe sections are actually 16 ft. long and 138 in. in diameter, instead of being 12 ft. long and 84 in. in diameter, as originally stated.

ENGINEERING NEWS-RECORD

Copyright 1940, by McGraw-Hill Publishing Company, Inc.

Volume 124, Number 3

F. E. Schmitt *and* Waldo G. Bowman, *Editors*

Van Tuyl Boughton, *Managing Editor*

New York: Charles S. Hill, Harold W. Richardson, Edward J. Cleary, R. H. Dodds, Archie N. Carter. *Chicago:* W. W. DeBerard. *San Francisco:* N. A. Bowers

Editorial Offices at 330 West 42nd Street, New York

JANUARY 18, 1940

FOR A NUMBER of years now the construction industry, while living on a fare of public works, has longed for the time when private construction would again become the backbone of its business. Substantial increases in industrial building and in residence construction last year raised the hope anew, but utilities, the other wheel horse, continued to exist on a hand-to-mouth basis in so far as expansion was concerned. Good news therefore is contained in a survey by *Electrical World* which shows that private and municipal electric light and power companies plan to spend $605,000,000 in 1940. This is 41 per cent more than last year and represents the largest budget since 1930. No federal undertakings are included in the total. Thus is the road to normalcy slowly being paved.

Business for Structural Engineers

POSSIBILITIES for increased business are as important to the structural engineer as to anyone else. An unexploited field is that of earthquake-resistant construction, for insurance company practices indicate that building owners cannot look to them for protection. For example, since earthquake damage risks cannot be diversified as well as can risks from losses by fire, a company, with due regard for safeguarding its policyholders, will issue only so much coverage in any one metropolitan area as it would be able to pay in the event of a major shake. Under these conditions a rather large percentage of the buildings in any major city within an earthquake zone could not possibly obtain earthquake insurance with conservative companies. Henry F. Badger, who speaks with authority from the viewpoint of the insurance field, has suggested (*ENR*, Dec. 21, 1939, p. 820) that building owners look to the designer for most of their protection against earthquakes. If the insurance premium savings cited, from 50 to 90 per cent, for buildings incorporating earthquake-resistant features are typical, and if a large number of buildings cannot get insurance in any event, proper design assumes a substantial money value. Here would seem to be one of those long-sought fields where a designer can really sell his services.

Improved Concrete Surfaces

STUDIES BEING MADE by the Bureau of Reclamation to see whether lining concrete forms with some of the available absorptive types of building board will improve the quality of the surface on sloping faces of spillways, should, if successful, be widely useful in fields beyond the scope of the present investigation. It is a well-known fact that where fresh concrete must be worked up against the underside of a sloping or flat form the concrete near the surface is weakened by entrapped air and by the movement of free water as both seek to rise to the top of the mass. Laitance also tends to accumulate in these areas. And in the finished structure, be it dam, bridge pier or building, these are the surfaces most exposed to attack by sun, rain and frost. The results are everywhere apparent in older concrete structures; in newer structures the use of stiff mixes and vibration have resulted in improvement, but the weakness has not been eliminated. The Bureau of Reclamation hopes to get further improvement through the use of absorptive form facing. The results of the extensive field tests, reported in our January 4 issue, will be watched with wide interest.

Our Shrinking America

THIS PROUD CONTINENT may disappear in time if it keeps on shrinking at the present rate, according to discussions of the shore protection experts last week. Observations by the federal Beach Erosion Board were cited to show that the sea is eating into our territory as much as a foot or two each year. While the United States thus wastes away, little is being done about it. Millions are spent to defend our coasts by fortifications and ships, but none to defend them by shore protection works. The government expects the private owner of shore-front property to provide protection, and this same private owner, who finds the job too big for him, expects the government to do it. The parties ought to get together, for evidently there is both public and private responsibility involved. Under a law passed ten years ago excellent preparatory work has been done through the Beach Erosion Board's studies. But studies alone hold back no waves. The

defense of our land at the sea frontier deserves more determined action; a federal-aid plan of participation in shore protection might help.

Profit From the Tool Shed

IN EVERY LIST of plant items for a construction job is a group labeled "supplies", which may include everything from nails, spike mauls, oil and gas to tarpaulins, wire rope and rubber boots. Seldom is much thought given to the purchase of such tool-shed supplies, probably because their cost is a comparatively minor item and because their quality does not seem susceptible of much improvement by more careful buying. Maintaining too rigidly such an attitude toward supplies may, however, result in unnecessary expense, for some supply items require intelligent purchase if maximum service and economy are to be obtained. Motor fuel and lubricants, for example, are no longer "gallon goods", but come in many grades. Wire rope can be purchased by the foot, but it comes in a variety of constructions and types, each suited to a particular service and offering a maximum of safety and wear for that particular service. Hand shovels made with a special type of steel may be available that would produce an over-all economy. Pliers, wrenches, nuts, bolts, saws and paint brushes are other supplies that have undergone changes which may be worth considering. A dollar saved is a dollar in the profit column. It is no less real if it is saved in the little things that are used on every construction job.

At the Crossroads

AMERICAN ENGINEERING COUNCIL finds itself at a poorly marked crossroads as it ends the second decade of its career as an integrating agency for the engineering societies of the nation. Its first decade was one of prosperity, the three Founder Societies that sponsored it having been liberal in their support, but the second decade has been one of continued curtailment of budgets, with some indication that the curtailment was due in part to loss of faith in the usefulness and desirability of such an agency as the council. A recent proposal that council be reduced to the status of an "embassy" in Washington for the whole engineering profession, with individual societies paying for any special studies that they might require, is now being studied. For the present that seems the most desirable route to follow, preferable to the road that leads to complete abandonment at this time of the idea that brought the council into being.

Cleaning Out Rackets

IN A DOZEN CITIES of the country groups of lawyers from the Department of Justice in Washington have been inquiring into the workings of the construction industry. As part of a planned offensive against illegal practices under the Sherman and Clayton anti-trust laws, which are claimed to have raised the cost of building to a point that endangers the national welfare, they have obtained thirteen impressive indictments against individuals, corporations, trade associations and labor unions. Money for carrying the investigation forward is running low, and Congress is being asked for an additional appropriation. Should the construction industry encourage the continuance of the program?

For many years the better elements in the industry have sought through measures of self-government and through support of the Federal Trade Commission to raise the standards of business practice and to stamp out illegal and damaging activities that are practiced by a few to the detriment of the whole industry. Neither effort has been very effective. Self-government needs not only a constitution, a bill of rights and a set of laws, but police power and court rulings to make its ideals effective. The Federal Trade Commission, which was set up to guide industry along a path of fair-trade practice, bogged down in its own ponderous machinery.

When the present investigation was begun as a part of the anti-monopoly drive, Thurman W. Arnold, Assistant Attorney General, outlined his basic philosophy in so far as the building industry was concerned. This was to collect data on alleged illegal practices in a group of cities simultaneously and bring indictments when justified. If convictions could then be obtained in the courts, these would stand as legal precedents to forestall a resumption of the practices. It was also in Mr. Arnold's plan to proceed against manufacturers, contractors and labor unions simultaneously and with equal vigor. Thus the investigation was to be nationwide and industry-wide at the same time, which was a new mode of attack.

On his record Mr. Arnold has lived up to his promises. No indictment has come to trial, but thirteen of them are ready in nine cities. They show no preference for either management or labor. They hit those in high as well as in less conspicuous places. They involve practices that the industry knows are wrong—rackets is the common term—and practices that have enjoyed a border-line reputation, whose legality or lack of it everyone would like to have defined. The cynicism that

greeted the investigation at the start was only natural. Too many Washington-inspired investigations in recent years had turned out to be witch hunts or political pillow fights in which a pillow loaded with a brick hit some innocent bystander. Mr. Arnold's activities have to date dissipated most of this criticism.

Those indicted so far may or may not be guilty as charged but if building materials or supply prices are being held up by collusion or coercion or if the materials are being kept out of some markets by labor intimidation, this new machinery for correcting such abuses should not be abandoned before it has been tested further.

Business practices in the construction industry at large are fair, honest and constructive. The majority of the industry needs to have the racket stigma, placed on it by a minority, removed. Mr. Arnold's probing should be continued.

Roads for Peace or War

IN 1940 organized roadbuilding in the United States ends its first quarter of a century with a record of outstanding engineering and administrative accomplishment. Another era with new problems and thinking is ahead. Against a backdrop picturing the story of past engineering progress and of the high degree of business stability reached by roadbuilding, this issue is planned to emphasize one element of this new thinking—the conception of our road system as an arm of our national defense.

It is important first to note that war-service road planning as developed by federal highway and military authorities entirely lacks the vicious implications commonly associated with the definition. In the World War all roads became war-service roads and all railways became military railways. Such will be the case in event of any future emergency, and on the highway normally required for commercial transport army transport will be given priority. That, broadly, is all that is meant by war-service roads.

Granted such understanding, war-service planning of roads should emerge into the open as a perfectly normal requirement. Although considerations of war service have regularly played a part in much past road location, they have seldom been discussed openly. Now, however, as the articles in this issue make plain, the conception of roads as agencies for wartime as well as for peace-time transport is frankly confessed. If commerce needs a road between industrial centers or to ports of embarkation, its military significance will be openly considered.

Such an attitude is no less than plain common sense; yet, because it smacks of militarization of roadbuilding, it may challenge opposition. Agencies opposed to road transport and agencies that receive diverted road funds and want more will cry aloud the example of German war roads. Even those who have highway development at heart will ask if money needed for commercial road system growth is to be curtailed to meet costs of special construction for war service. Are we, they will ask, to forget all that has been learned of business highway economics and accept defense purposes as the criterion for planning and design? These questions are legitimate and deserve positive answers from those qualified to answer them.

And answers can be positive. Of the 80,000-mi. highway grid shown on the strategic road map on a following page it is estimated that not more than 2,000 mi. have a military function that transcends their peacetime importance. Of the standard specification requirements for modern arterial road structure not one need be increased to serve war transport. With the most important commercial road requirement of today—express roads into and through cities—war-service road requirements coincide exactly.

And because of this, roadbuilding science is prepared to meet the demands of war service in the regular stride of commercial road design and construction. Whether in new construction or in revamping old roads to present standards, engineering now has the design knowledge and the materials, machinery and craftsmanship to meet all requirements. And to support design and construction proficiency, a score and a half years have stabilized the federal and state administrative and financing machinery for public roads development. In the last four years budgeting of expenditures for the coming year has each year become more exact, and the difference in available funds from year to year shows a progressive increase due to continuing traffic growth.

A remarkably stabilized roadbuilding business is ready to attack all roadbuilding problems that face it, be they related to regional or industrial area roads or to correlation of peace-time requirements with wartime demands. The articles on defense highways in this issue reflect the most authoritative thinking that has been done on this question. And they amply demonstrate that road planning for war service can be a completely constructive force for commercial highway system development.

ROADS FOR NATIONAL DEFENSE

Because we need roads for the speedy and efficient marshalling of men and materials in case of war, the two top government officials concerned—Gen. George V. Strong, Assistant Chief of Staff, War Plans Division, and Thomas H. MacDonald, Commissioner, Public Roads Administration—are conferring frequently these days, with the result that the requirements for national defense highways are rapidly crystallizing into a program that is authoritatively discussed in a group of articles beginning on the next page.

THE ASSISTANT SECRETARY OF WAR
WASHINGTON

December 28, 1939

Mr. Waldo G. Bowman, Editor
Engineering News-Record
New York, N. Y.

Dear Mr. Bowman:

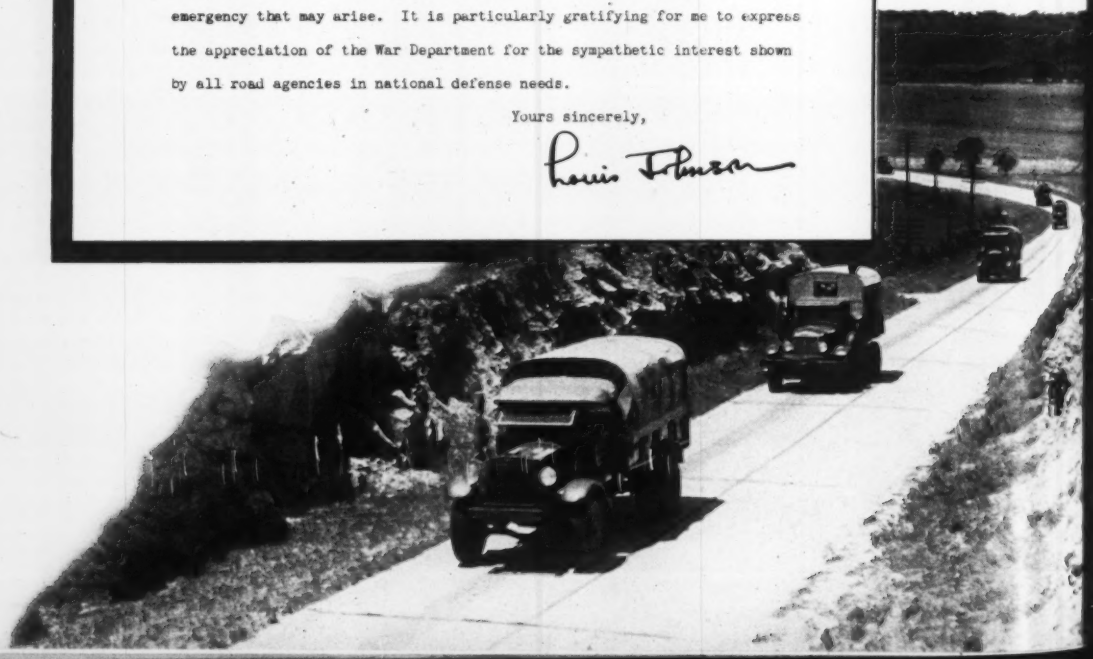
In devoting an issue of Engineering News-Record to the subject of "Roads for National Defense" you are doing a real public service. Published as it is just prior to the convention and equipment show of the American Road Builders Association in Chicago, the issue will serve to bring to the great roadbuilding fraternity a clarification of the official viewpoint and a proper understanding of the fundamental objectives of road planning for military as well as for civil purposes.

It is appropriate for me to emphasize the War Department's desire to coordinate its needs with those of peacetime transport. This policy was enunciated by General Pershing when our great roadbuilding era began after the World War. It has been consistently followed with the result that we have a highly efficient system to serve us in peace or in war.

All of us, whether in the War Department, Public Roads Administration, state, county or city highway departments or as individuals, are working toward a common end--insuring the security of America against any emergency that may arise. It is particularly gratifying for me to express the appreciation of the War Department for the sympathetic interest shown by all road agencies in national defense needs.

Yours sincerely,

Louis Johnson



Wide World Photo

FIG. I. PEACE AND WAR MEET ON THE HIGHWAY. IT'S ONLY MANEUVERS BUT IT MIGHT BE REAL.

Roads for National Defense

Contents in Brief—Military road needs in the United States are not incompatible with peacetime highway requirements. The War Department's first priority system is not greatly different from our main interregional net. Military requirements for road surfaces and bridges are not more severe than civil requirements, but improvements in these details are necessary. Some access roads to military reservations need to be built, but the principal need is for express roads in metropolitan areas to serve the requirements of industrial mobilization.

MILITARY OPERATIONS have been influenced by roads throughout recorded history. One has but to recall the role that roads played in the campaigns of Imperial Rome for an early example, while of more recent memory is Germany's speedy conquest of Poland only last September, rendered easy by quick mobilization over a system of strategic express highways. And, as the army-built roads of twenty centuries ago served the double function of tying together the commerce of the Roman Empire and providing passage for its legions, so do the roads of today serve both a commercial and a military purpose.

Between the ancient and the modern there still is this kinship, but little else is left. Modern warfare with mobile equipment, machine-hauled troops and mechanized supply not only has changed the road but it has enhanced its importance.

Peace-time road system serves

Fortunately the roads of importance to the national defense of the United States today are, with few exceptions, the same roads that daily carry millions of commercial and pleasure vehicles and with which every motorist is familiar.

Because of the favored geographical position of the United States, separated from a large part of the world by wide oceans on two sides and flanked by friendly neighbors on its other borders, our military road problem is little affected by requirements for battle maneuver. Rather, it is a problem of transport from and

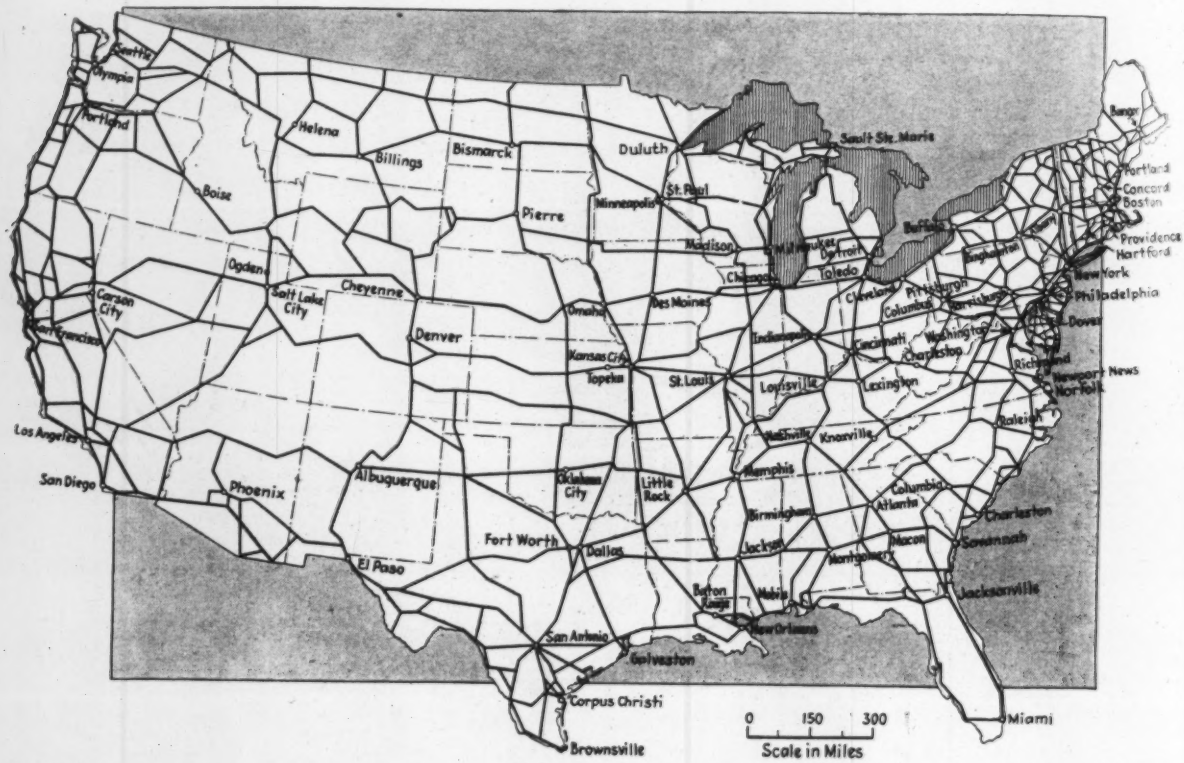


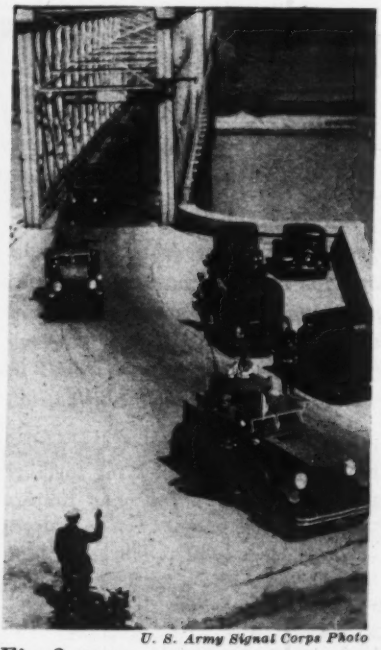
Fig. 2. Diagram of strategic highways now being studied. The system shown is divided into three priority classes so far as importance and urge for improvement are concerned.

to strategic points. Consequently, if military needs are largely transport needs a road system developed for peace-time business transport can be a military road system.

The road policy of the War Department not only takes full account of this fact but it provides for designing military equipment to make no greater demands on road alignment, grades, surface and structures than does everyday commercial traffic. That this policy is sound has been proved again recently in a detailed re-study of our military road needs, which has shown that nearly everything that could possibly be required is already on the books of state highway departments and the Public Roads Administration for development to meet peacetime traffic demands.

The national defense grid

The Army's ideas on highways are summarized in the War Department Special Highway Map, the latest edition of which was completed last September. As reproduced in Fig. 2 this special map shows about 80,000 miles of road which the Army considers important, divided among three degrees of priority, the system of first priority following very closely, in its general outlines, the 29,000-mile system of interregional highways proposed by the Public Roads Administration in its report of last Spring (see map on page 84). What these priorities mean in terms of actual construction is difficult to pin down precisely. War Department priority recommendations have at present no legal force, but since a special War Department committee works closely with the PRA, defense road needs are well taken care of.

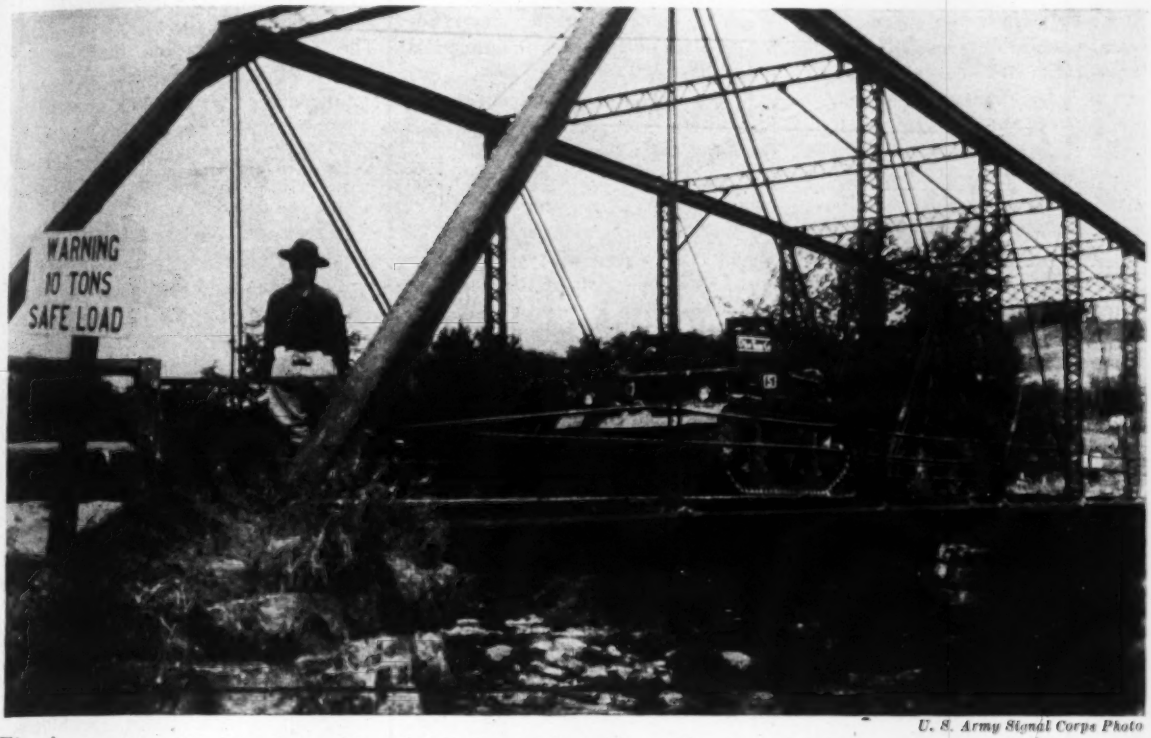


U. S. Army Signal Corps Photo

Fig. 3. Not too good either for peace or war. Bridge too narrow and approach is curved.

Feeder roads for defense grid

The roads in the system illustrated above are what the War Department refers to as strategic highways. There are two other classes of highways recognized as important to the national defense. Both are feeders. The first of these classes of roads are those in the vicinity of military posts and mobilization centers. The War Department calls them access roads. Although comparatively short in length and inexpensive to construct, access roads are necessary to diminish traffic hazards in congested training centers. The second class of feeder road is that which serves wartime industrial areas. One has but to consider the implication of the War Department's Industrial Mobilization Plan, under which 10,000 factories have been completely cataloged and in some measure allocated to definite



U. S. Army Signal Corps Photo

Fig. 4. Stretching the safety factor. Many light bridges such as this need to be replaced for commercial as well as military traffic. In this instance tanks had to cross one at a time.

tasks for the manufacture of supplies in an emergency, to appreciate the importance of roads in industrial areas.

Railways and highways

The Army plan of industrial mobilization is built around the railroads as the primary means of transport. The possibility is recognized, however, that a great wartime increase in traffic might seriously overload the rails. In this event, traffic now carried by the railroads would be transferred to the highways to make room for essential shipments. This means a quantitative rather than a qualitative change in highway traffic, which accounts for the close resemblance between the first priority Army grid and PRA's interregional map.

Although the rails will dominate the long-haul picture in wartime, highways will have a vital part to play in short-haul transport. This is reflected in the Army's map in greater concentration of routes in the eastern half of the country—the heavy industry region—as compared with the interregional layout. Thus, in the midwest, the Army asks that the Toledo-Indianapolis-Chicago triangle be completed by a Toledo-Indianapolis connection, that interregional routes 16 and 18 be connected between Louisville and Cincinnati, and that a wide loop be run around Chicago intersecting five of the six major highways joining there. Farther east, the Army map gives first priority to a road between Buffalo and New York via Binghamton as a supplement to PRA's Albany route. In New England, the Army map would complete the Springfield-Worcester-Hartford triangle with a road from Worcester to Hartford, which would also extend south and west to Danbury.

Not reflected on the map are the road necessities inherent in the industrial mobilization plans. The one field in which the truck will have a virtual monopoly is transportation within metropolitan areas, from plant to plant within cities and from suburban plants to urban rail terminals. Therefore, plans to improve vehicle facilities in and near cities—such as the express highway legislation now before Congress provides for—are of great importance.

Military access roads

In any mobilization, unless railway congestion became too great, it is likely that even army trucks and tanks would be moved on flat cars, both in the interests of speed and to save wear and tear on equipment. Interior concentration points for men and equipment, however, would have to have good highway service. Many of the Army's military reservations and proposed concentration centers are in locations without good roads, a fact which poses a still unsolved problem. The War Department feels that all its funds should be used for strictly military purposes and is unwilling to spend any money on roads. On the other hand, many of the states are understandably hesitant to pay half the cost of roads which they claim are of very little local utility.

In addition to local access roads the War Department lists certain highways which are not included in the interregional system as first priority roads. Examples are a road from Cheyenne to Billings, Mont., a road from Macon to Savannah, Ga., and two more or less parallel roads from Richmond to Newport News and Norfolk in Virginia.

For war at home

Unlikely as the eventuality may be, the Army has to take into account in its planning the possibility that this country—or this continent—might be invaded. As might be expected, this consideration causes few changes in highway layout except along the coasts. In the West, priority has been given to a coastal road parallel to

interregional route 8; along the mountainous and thus less vulnerable sections of the coastline this road has second priority. The Army also asks for a road from San Diego to Brownsville, Tex., instead of or in addition to interregional 3.

In the North first priority is given to a road from Duluth along the south shore of Lake Superior to Sault Ste. Marie. This is joined by a route running north from Milwaukee and by another going up into the Michigan peninsula from Detroit. Finally in the East a group of coastal defense roads radiate from New York City, one running south as far as Atlantic City, another extending the length of Long Island, and a third going north along the coast to Boston via Providence.

It is evident that some new roads are required. In the main, however, the necessary roads are in existence and usable, while their inadequacies are reflected in such details as light or narrow bridges, excessive curvature or grades and weak surfaces. These inadequacies as well as the military traffic and loads that cause them are discussed in detail in other articles in this issue.

Industrial area roads

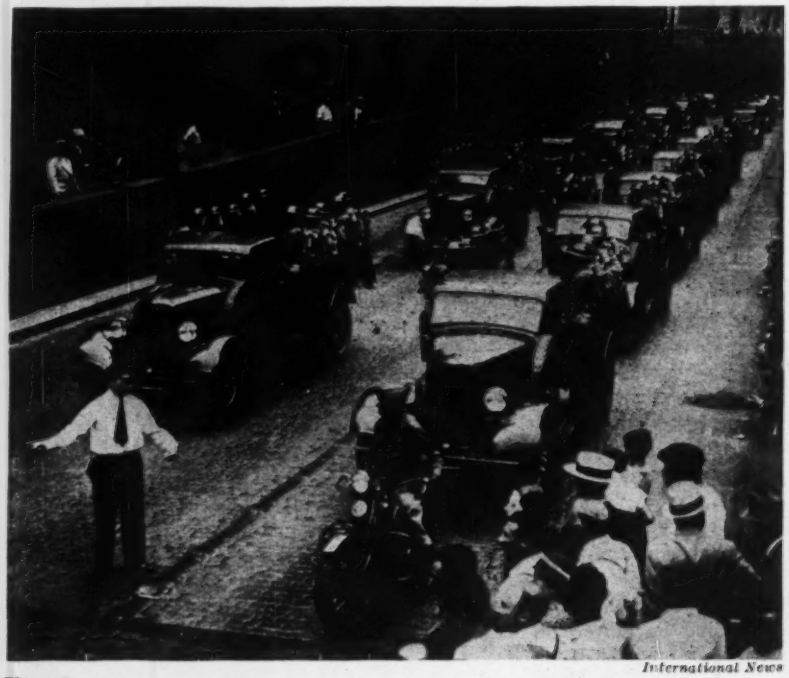
This is the picture of the need for improving our existing road system. When we come to consider our needs for new traffic facilities in industrial areas, the really big weakness in our highway system is encountered. Every recent report on highway needs has placed metropolitan express highways first, since all studies of peacetime traffic in or near cities show that existing facilities are seriously inadequate. It has been estimated that as much as 90 per cent of the traffic on main highways at the entrances to large cities is bound to or from points in the cities themselves and cannot be passed around them. Within our cities are the chief obstacles to commercial highway transport and thus to efficient national defense as well.

With characteristic conservatism a spokesman for the War Department has said, "In some centers industrial mobilization would probably result in considerable highway traffic congestion." Detailed PRA and other traffic reports on such important industrial cities as Los Angeles, Detroit, Boston, Chicago and Pittsburgh, made with only peace-time requirements in mind, show that this congestion is already a fact. In Los Angeles County, for example, there are one million vehicles in daily use (40 per cent of the state's total), and by 1950 it is estimated this number will double. Between 1930 and 1936 alone, traffic on the most important routes increased 40 to 60 per cent. The report points out that on the 11,316 miles of highways in the country there is an economic loss of $10,000,000 annually and that the only way traffic can be efficiently served is by a system of freeways elevated in the downtown area.

In Detroit, the situation is little different. Its system of radiating arteries was planned to serve a city with a single business district but expansion and development of numerous outlying industrial and business centers has created extreme traffic complications for the cross-city trucking necessary in this third largest manufacturing city in the United States. The report on Detroit likewise recommends construction of cross-town express routes and in addition the building of a belt around the central business district.

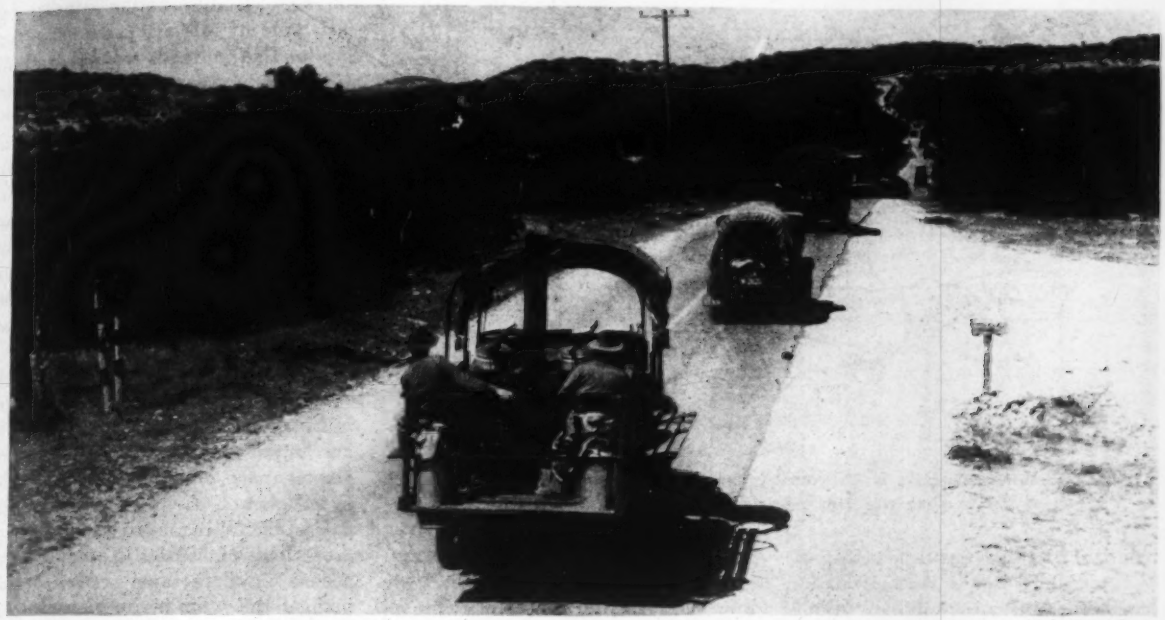
In Boston traffic experts concluded that provision must be made for express roads as the only way to cope successfully with traffic problems. How important express roads may be is indicated by a report on St. Louis which points out that each of 30 intersections serves from 35,000 to 50,000 vehicles every 24 hours. Chicago is little better served by metropolitan express highways than these cities, and Pittsburgh, probably the No. 1 industrial city in wartime as well as in peace, has an even more complicated problem.

In 1921, in testifying before a Congressional committee, General Pershing laid the ghost of wide transcontinental superhighways for national defense needs by emphasizing the necessity for a highway net that would blanket the country. He thereby did much to direct the course of roadbuilding policy for 20 years thereafter. Today, we find that the road network is no longer a major problem, however much of a task it will be to bring it up to reasonable standards, but that roads serving factories where industrial supplies and munitions are made are vitally needed. As in 1921, the military needs coincide with commercial requirements. Perhaps the major effort in the next 20 years will see the problem of the industrial area express road solved. Such a result would greatly enhance the efficiency of peacetime business and would assure against a breakdown of transportation facilities when a wartime load turns our factories to feverish activity.



International News

Fig. 5. Express roads into cities, like New York's Holland Tunnel shown here in military dress, are what the country needs for more effective national defense.



Wide World Photo

FIG. 1. THE ARMY STILL MOVES ON ITS STOMACH, BUT IT NEEDS BETTER ROADS THAN IT USED TO.

War and the Interregional Highway Plan

H. S. FAIRBANK

Chief, Division of Information, Public Roads Administration
Federal Works Agency, Washington, D. C.

***Contents in Brief**—Nearly all of the proposed 30,000-mile interregional highway net is included in the first priority class of the 80,000-mile national defense road system. PRA is collecting detailed information on the condition of every mile of this 80,000-mile system, which will be checked against army transportation requirements in arriving at a schedule of improvements.*

IN ITS REPORT, "Toll Roads and Free Roads," prepared in the spring of 1939, the Public Roads Administration suggested the designation and progressive improvement of a system of direct interregional highways designed to facilitate movements of motor vehicles engaged in travel over relatively long distances. Such a system, limited to one per cent of the total rural highway mileage of the country, would provide connections between all of the more important cities of the United States. To illustrate its proposal, the Administration included in its report a map showing a system of 26,700 miles. This tentative system has since been revised, with the aid of the state highway departments, to include the routes shown in Fig. 2, and now totals 29,300 miles.

Obviously, this system is not designed as a complete answer to all highway needs. Rather, joining by direct courses the major cities of the country and passing centrally through all significant regions, its limited purpose is that of accommodating the important traffic of longer range that moves between such large cities and regions. In fact, the lines of the interregional system are those over which there is now moving the heaviest traffic to be found on any main roads in the respective regions; and collectively it is estimated that all of the routes of the system would serve not less than an eighth of the total traffic moving over all rural roads. Furthermore, the system is identified with the major concentrations of population, its importance in this respect being evidenced by the fact that the homes of approximately 60 per cent of the total population of the country are within the counties directly traversed. And finally, this close relationship to population distribution is, of course, indicative of a similarly close agreement with the distribution of industrial activity.

The system and national defense

The foregoing is written in terms of the relation of the proposed system to the peace-time needs of the country. Fortunately, however, the same system, with a few exceptions and additions, is similarly important for the marshalling of men and materials that would be needed in case of war. But again it must be noted that, just as the interregional system is only a partial answer to the highway transport needs of peace, so it would meet only in part, though in most important part, the require-

Fig. 2. On this 29,300-mile interregional highway grid, laid out for civil use, will move much of the wartime transport necessary to our national defense.

ments of essential war-time transport.

The Public Roads Administration has been constantly advised by the War Department of the highway needs of the national defense since 1922. It was in that year that the War Department first indicated the desirable priority of improvement of the country's roads from the military standpoint; and all of the routes then indicated were included in the designated federal-aid system. In 1935 the War Department made some revisions in the system and established priorities of route improvements within the designated system; and again, at the present time, revisions are being made which will result in a system of some 80,000 miles, to parts of which priorities of the first, second, and third orders will be assigned.

The selection of these routes and the assignment of improvement priorities rest upon certain general principles agreed upon by the War Department and the Public Roads Administration as far back as 1922.

Defense road principles

These were: First, that the highways essential for peace-time commerce and national development would, in general, be identical with those required for military purposes.

Second, that the location of highways and the priorities of construction are normally a matter for determination by the Public Roads Administration and the state highway authorities concerned. This being the case, the War Department ordinarily will refrain from recommending specific highway routes except in the most critical strategic areas.

Third, that a general network of improved roads, connecting important depots, mobilization and industrial centers, has more strategic value than transcontinental roads.

Fourth, that the War Department's primary interest is that of insuring adequate highway facilities between important strategic points and vital areas.

From this it is evident that the road system for war transport is not a system set apart from the roads designed for peace-time transport. If an interregional system is necessary for peace-time use, it is also necessary, and in almost equal degree, for the national defense.

Logging present road conditions

The Public Roads Administration, with the cooperation of all state highway departments, is now investigating in detail the condition of the more than 80,000 miles of main highways in which the War Department has indicated a special interest. This mileage includes more than 90 per cent of the interregional system, and a group of other main roads next in importance from the standpoint of military use in connection with war-time mobilization. Particular attention is also being given to the need for certain other improved routes providing access to military cantonments, arsenals, depots, concentration points and certain special defense areas; this group has an aggregate length of less than 2,000 miles.

The state highway departments have already forwarded to Washington detailed information concerning each mile of this extensive network; and the Public Roads Administration, as rapidly as possible, is compiling this information in the form necessary to permit an estimate to be formed of the adequacy of existing improvements and the need of additional construction. Fig. 3 is an example of the charts that are being drawn to record the conditions, this one being for a section of road in Florida between Miami and a point near Tampa.

On the road in Florida, for which condition information is presented in Fig. 3, it will be observed that the maximum gross load to which the greater part of the section is subjected with a frequency of once a day is 35,000 lb.; once in ten days a gross load of 40,000 lb. may be expected on these same sections; and both of these limits are exceeded on a short section of the route near the towns of Sarasota, Bradenton and Palmetto.

Comparison of this normal heaviest loading with the rated capacity of bridges on the route, as indicated in another part of the diagram, shows that throughout nearly half of the section there are bridges almost every mile of the way of designed capacity substantially less than the maximum loads to which they are subjected with considerable frequency by ordinary peace-time usage; and they would be similarly overtaxed by military loads. The bridge condition on this particular section of the interregional system is less favorable than the average; but throughout the system it is generally true that inadequacies of bridges, rather than those of road surfaces, are the cause of the most serious limitations upon the utilization and capacity of the routes, either by peace-time or war traffic.

This does not mean, however, that there are not numerous deficiencies of the roadways proper. There are; and such deficiencies are relatively more serious, as a rule, in the vicinity of the larger cities where traffic is heaviest for they include narrow surface width, narrow rights-of-way, closely hemmed in by property developments that present great difficulties to adequate improvement, faults of alignment, sharp curvature, and short sight distances.

To determine the degree and location of inadequacy within the system

for service of wartime traffic, the existing physical conditions of the routes are being examined in the light of a knowledge of the characteristics of critical military vehicles and mobile units as described in another article in this issue; and on all routes in the system on which addition of the military movement is likely to swell the normal volume of traffic to a total above the normal capacity of a two-lane roadway, special effort is being made to anticipate the amount of the wartime traffic increase. In the main this condition exists on routes in the vicinity of the larger industrial centers and of military depots, cantonments, arsenals, and concentration points. Until the studies now in progress are completed, it will be impossible to indicate the extent of the improvement that will be needed to meet the requirements adequately.

Future roadbuilding program

The principal effect of a consideration of national defense needs upon the future highway improvement program is likely to be an acceleration of the rate of improvement of the more heavily traveled routes. The effect of war would be a sudden increase in the total volume of highway transportation by an amount that would normally develop over a considerably longer period. Significant increases in traffic, such as would affect the design of the roads, would be expected, however, upon a rather restricted mileage in the vicinity of the important centers of industrial and military activity. A relatively minor effect, because of the limited mileage involved, will be the inclusion in the program of a certain amount of new road construction in the vicinity of new cantonments, air bases, etc. The location of such new reservations, made possible by the enlarged provision for national defense, in most instances requires the closing of existing roads, generally of the secondary classification. The reopening of the communications thus interrupted and the construction of the new access roads required for the service of the reservations will be essential elements of the highway program in the years just ahead, regardless of the contingency of war.

In a measure also, the improvement of the roads of the interregional system will be affected by the highway requirements of the army in peace time. The maneuvers being conducted this winter in the southern states will afford an example of what may be expected more frequently in the future. Arrangements are being made for the assignment of representatives of the Public Roads Administration to observe the principal highway movements in connection with this large southern concentration. The purpose of these observations will be to ascertain directly the effect of existing highway conditions on the efficiency of the operations, and determine what changes in existing road locations and designs may be desirable to fit the road system, and especially such major roads as are included in the interregional system, for the combined efficient uses of both civil and military movements.

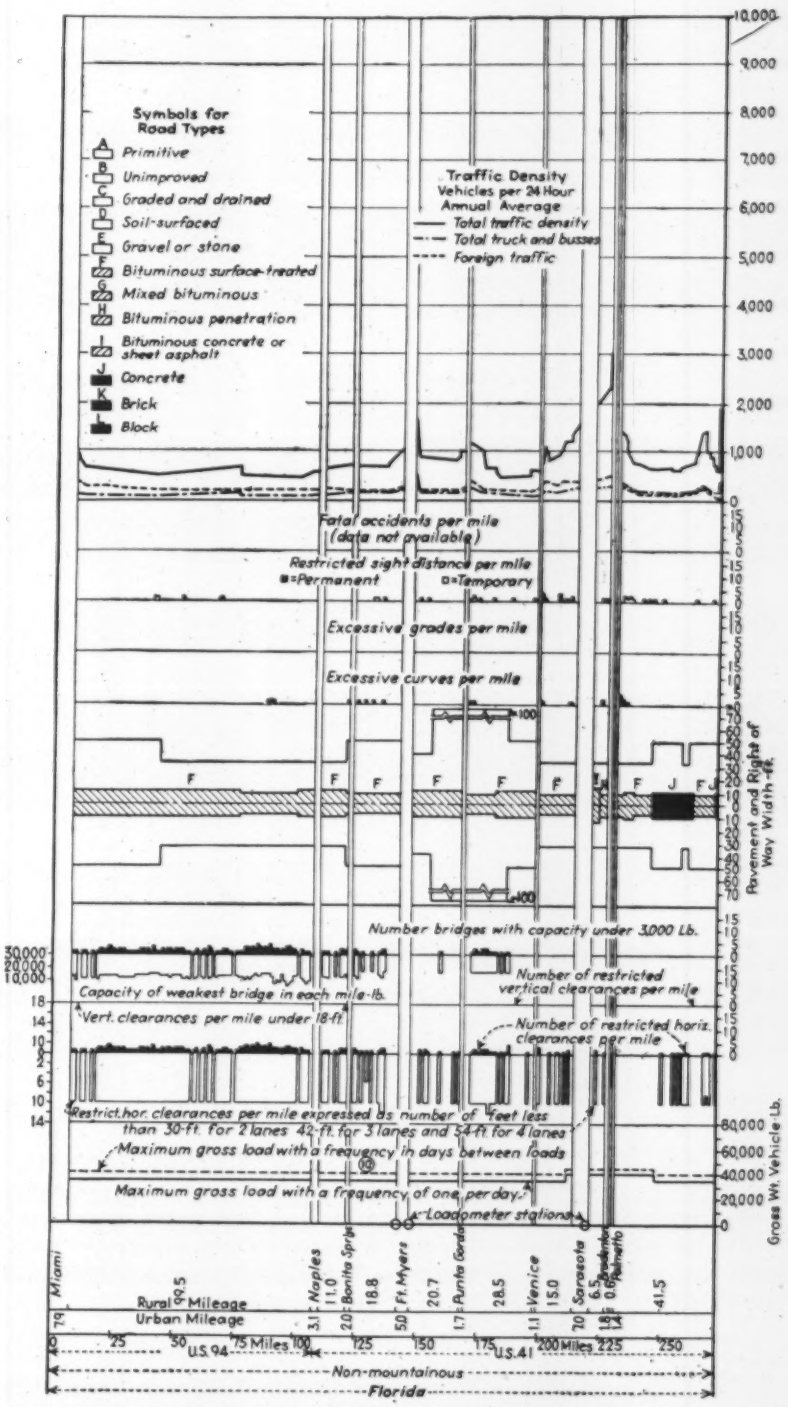

Symbols for Road Types
A Primitive
B Unimproved
C Graded and drained
D Soil-surfaced
E Gravel or stone
F Bituminous surface-treated
G Mixed bituminous
H Bituminous penetration
J Bituminous concrete or sheet asphalt
J Concrete
K Brick
Block
Traffic Density Vehicles per 24 Hour Annual Average
Total traffic density
Total truck and busses
Foreign traffic
Fatal accidents per mile (data not available)
Restricted sight distance per mile ■=Permanent □=Temporary
Excessive grades per mile
Excessive curves per mile
Pavement and Right of Way Width-ft.
Number bridges with capacity under 3,000 Lb.
Capacity of weakest bridge in each mile-lb.
Number of restricted vertical clearances per mile
Vert. clearances per mile under 18-ft.
Number of restricted horiz. clearances per mile
Restrict. hor. clearances per mile expressed as number of feet less than 30-ft. for 2 lanes 42-ft. for 3 lanes and 54-ft. for 4 lanes
Maximum gross load with a frequency in days between loads
Maximum gross load with a frequency of one per day
Loadometer stations
Gross Wt. Vehicle Lb.
Miami
Naples
Bonita Spgs.
Ft. Myers
Punta Gorda
Venice
Sarasota
Palmetto
Rural Mileage
Urban Mileage
U.S. 94
U.S. 41
Non-mountainous
Florida

Fig. 3. How data on road conditions are being charted by the PRA. This chart shows a 275-mile stretch between Miami and Tampa, Fla.

Acme Photo

FIG. 1. BATTLE WAGONS REQUIRE GOOD ROADS, AND TANKS MAKE POOR ROADS WORSE.

Loads and Roads For War and Peace

LAWRENCE S. TUTTLÉ

Senior Highway Engineer-Economist, Public Roads Administration, Washington, D. C.

Contents in Brief—Military equipment design has been coordinated with highway requirements for wheel loads and axle spacings. Even critical loads of guns and combat cars are less than many commercial loads. Universal use of pneumatic tires and rubber inserts on tanks saves the road surface. Greatest road inadequacies are in width and alignment. Standards are now being determined but it is certain that much of the 80,000-mile strategic system will require improvement.

THE RESULT of the principle adopted by the War Department at the beginning of the era of modern highway construction that military road requirements should correspond as closely as possible with civilian road requirements has resulted in a studied policy that specifications for military vehicles shall diverge as little as possible from similar vehicles in commercial use. The Engineer Board of the War Department in a recent statement emphasizes this policy again by pointing out that commercial vehicles are largely used by the army, and that in an emergency any vehicles available will be used. The board, finding a marked tendency in recent years toward increased weight, particularly in artillery prime movers and motor vehicles, also stresses the necessity of regarding recommended load limits as true maxima to be approached only in exceptional cases.

The wisdom of this policy is evident when it is considered that army vehicles may have to use all types of roads and all types of bridges. What the result of this policy has been, in so far as size and weight limitations for military vehicles are concerned, is important to the road designer.

Gross weight requirements

Present regulations provide a maximum gross weight of 15 tons for single-unit vehicles designed to accompany an army in the field and of 7½ tons for similar vehicles designed to accompany an infantry or cavalry division, except combat cars and light tanks which are limited to 10 tons. The gross weights of single-axle towed loads are limited to 5 tons for an army and 2½ tons for a division, and of 2-axle towed loads to 10 tons and 5 tons respectively.

This regulation was adopted as

being the easiest to apply and the most readily understood by all concerned, but it produces some inconsistencies and is not flexible. For example, a 15-ton truck drawing a 10-ton two-axle gun carriage is allowed, but an actual combination of the same gross weight, an 11½-ton tractor drawing a 13½-ton two-axle gun carriage, is not allowed. Actually, either of these combinations could produce greater stresses in short-span bridges or floor systems or cause greater road-surface damage than the other depending upon the axle loads and axle spacing in the combination.

The need for a consideration of axle spacing in relation to gross load has led to a recommendation that the formula of the A.A.S.H.O. be adopted; namely, $W = C(L + 40)$, where W is the gross weight of vehicle or combination; C is a coefficient intended to give allowable weights with H-15 bridges; and L is the distance in feet between the first and last axles of a vehicle or combination.

The value of C recommended by the committee on bridges and structures of the A.A.S.H.O. is 750, where L is over 18 ft. and 650 where it is 18 ft. or less, and these values are believed to be satisfactory for corps and army limitations. Smaller coefficients are desirable for division limitations since the present pontoon bridge is a 7½-ton structure (now being redesigned for 10 tons), and the portable highway bridge is an H-10 structure. The recommended values of C are 325 for an axle spacing of 18 ft. or less, and 375 for a spacing exceeding 18 ft. for vehicles or combinations designed to accompany a division, and 600 and 700 for corresponding vehicles or combinations designed to accompany an army. In applying the formula to track-laying vehicles, such as tractors or tanks, the gross weight is assumed to be concentrated in two equal loads at the ends of the ground contact of the track or at the quarter points.

Vehicle axle loads

Of even greater significance than gross weight in the design of road pavements and surfaces are wheel loads, their distribution and frequency of occurrence. A recent series of articles in *Public Roads* ("Application of the Results of Research to the Structural Design of Concrete Pavements," by E. F. Kelley, Chief, Division of Tests, Public Roads Administration, Vol. 20, Nos. 5 and 6) points out that when axle spacing is in excess of about 3 ft. the critical stress is primarily a function of wheel load and not gross weight, and that impact as well as static load is an important factor.

It has been found that, while for given conditions of speed, tire equipment and road roughness, the magnitude of an impact reaction increases with the wheel load, the ratio between the total impact reaction and the wheel load is not a constant. This ratio tends to decrease as the magnitude of the wheel load increases; first, because of a variation in the relationship between the sprung and unsprung components of the wheel load and second, because of the greater ability of the large tire sizes to absorb irregularities in the road.

Solid, cushion and pneumatic tires offer increasing degrees of cushioning in the order named. With tires of the pneumatic type, tests show that,

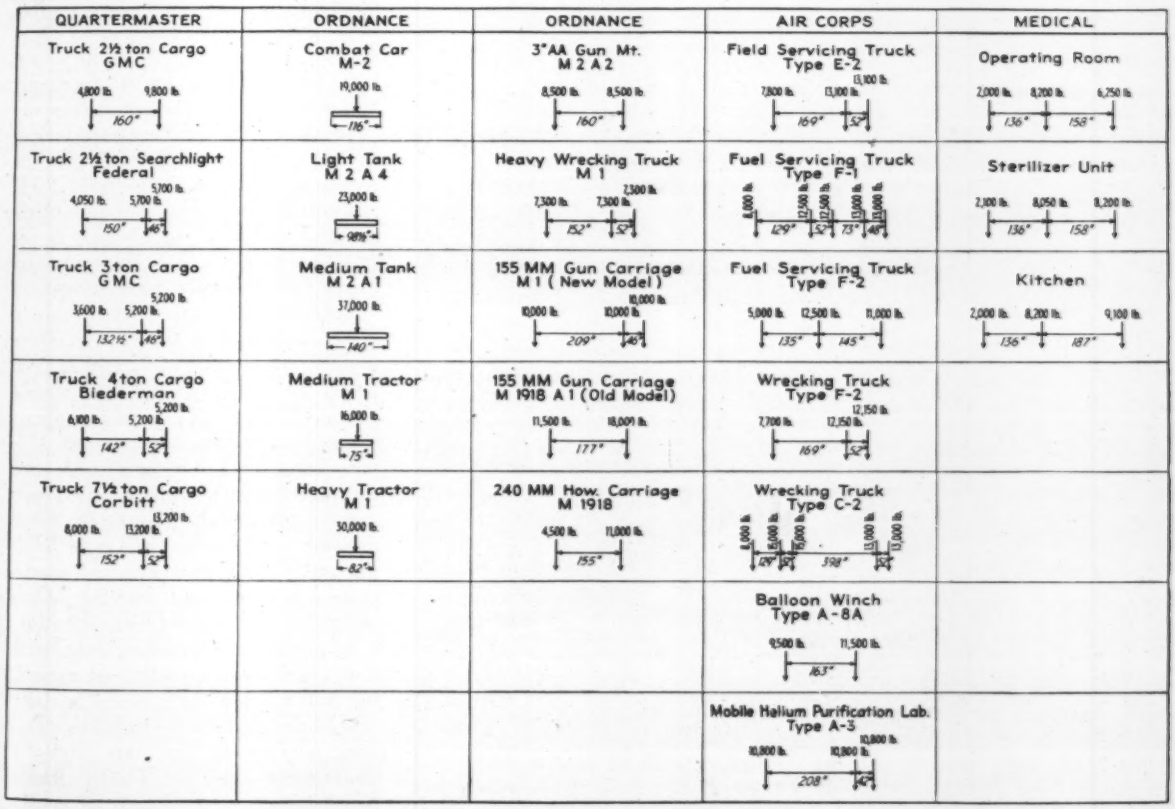


Fig. 2. How heavy military vehicles load the road. The 155-mm. gun carriage and the 7½-ton cargo truck are the giants.

other conditions being equal, the impact reactions in excess of the static load are approximately in proportion to the inflation pressures used in the tires.

Tests with pneumatic tires indicate that impact increases with speed to a general maximum at about 50 mph and remains constant up to 70 mph. With solid tires, however, impact reactions increase very much more rapidly with speed, and reach much higher maximum values. A practical limit of about 20 mph is imposed by the relative inability of the solid tire to dissipate generated heat.

These facts have been widely recognized in the design of modern military vehicles, so that there is universal use of pneumatic tires, a widespread use of the balloon type, and a tendency to use tire sizes more than adequate for anticipated loads and springing that is adequate for high-speed transport. Also, concentrated loads are carried by articulated 2-axle bogies equipped with dual tires. Present regulations limit axle loads on high-pressure pneumatic, solid or cushion tires to 16,000 lb. for speeds greater than 10 mph, and to 18,000 lb. for balloon tires; also axle spacing is limited to not less than 40 in. This regulation places no speed restriction on solid-tired vehicles, but it is now recommended that this be changed to require that all vehicles operated at more than 10 mph be equipped with pneumatic tires.

Load regulations also include limits on track-laying vehicles of 5,000 lb. per lin. ft. of ground contact and a maximum ground contact pressure of 15 lb. per sq.in. With respect to tire load the recommendation of the Engineer Board is that the standard of the Western Association of State Highway Officials be adopted; namely, 600 lb. per in. of width, the width being the nominal diameter of the tire. In this connection it is worthy of note that the War Department has put into use on all new track-laying vehicles a track incorporating rubber inserts to cushion the contact and reduce damage to road surfaces. Furthermore, for the same purpose "street cleats" are applicable to the older types of track.

Present regulations restrict width to 96 in., except for combat cars, tanks and the heavier mobile guns, which are restricted to 108 in. and of which the widest is the 155-mm. gun (M1918A1) which is 106 in. The recommendation is that 96 in. be the limit without qualification and, since railway widths and clearances also make it desirable to stay within this limitation, that wider vehicles be allowed only under special permission.

As to height, since railway clearances impose a limit of about 10½ ft., military regulations restrict height to 11 ft. and state that this must be reducible to 10½ ft. for rail shipment. Such a limitation is well within the A.A.S.H.O. recommendation of 12½ ft. and that in use in most states. Apparently it has not been thought necessary to limit the length of military vehicles, but if it later proves to be advisable the recommendation is that the A.A.S.H.O. standard be adopted, 35 ft. for single vehicles and 45 ft. for combinations.

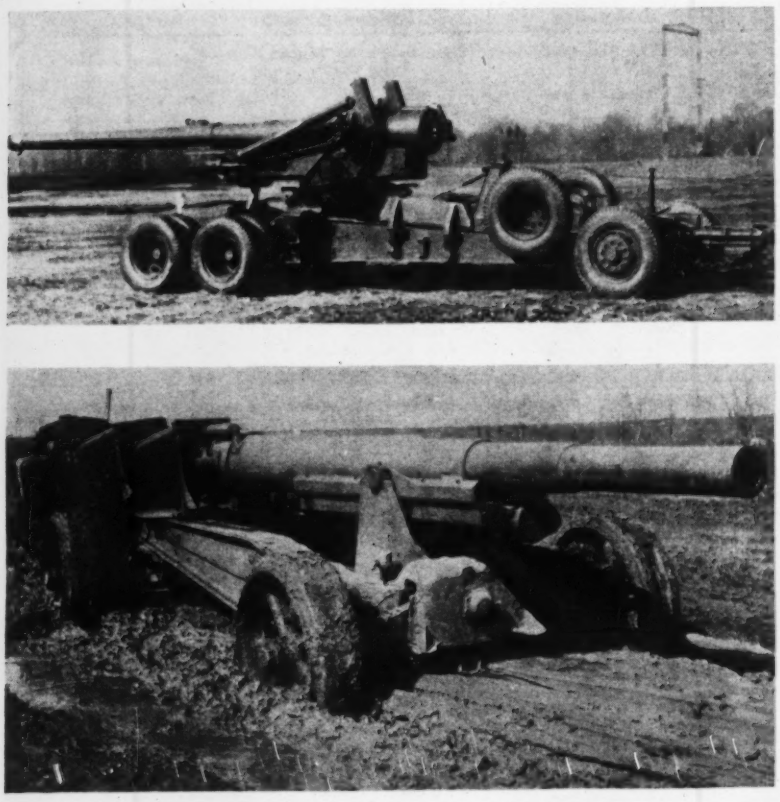


Fig. 3. "It Can't Happen Here" both because of all-weather road surfaces and because the single-axle solid-tire rear mounting of the old 155-mm. gun carriage has been superseded by the pneumatic-tired twin-axle mounting shown at the top.

Critical military loads

From the foregoing it is apparent that modern highway surfaces which have proved satisfactory in commercial service should generally satisfy military requirements for similar load frequency applications. There are, however, exceptional and critical loads in current military use, and Fig. 2 shows the axle loads and spacings of the heaviest equipment. In most cases, wheel loads may be assumed as one-half the axle loads shown. A noteworthy accomplishment of military engineering is the fact that even on these exceptionally heavy vehicles, axle loads have been maintained at relatively low values.

The critical load for road surfaces is undoubtedly that of 18,000 lb., imposed by the solid-tired rear wheels of the 155-mm. (M1918A1) gun carriage. In contrast, the modern 155-mm. gun, (M1) is equipped with three axles and pneumatic tires, each axle carrying only 10,000 lb. Final decision on the prime mover or hauling unit for the new gun has apparently not been made, but the 7½-ton cargo truck is under consideration.

In commercial practice, axle loads and wheel loads equaling or exceeding military loads are found in daily use. In the cooperative highway planning surveys of the state highway departments and the Public Roads Administration, thousands of trucks have been stopped and weighed on

our main highways. By far the greatest proportion of these trucks are in the lighter axle-load group, but an important proportion are found in the heavier axle-load group and an appreciable number equal or exceed 18,000 lb. It is significant to note that many of the heavier axle loads were recorded on light trucks of the 1½-ton rated capacity class. Army engineering practice also correlates engine power and tire capacity for given loads. In contrast, a very considerable proportion of the trucks in commercial use are under-tired.

Road surface adequacy

Although modern road surfaces which have proved satisfactory for civilian and commercial traffic will generally be adequate for military traffic, there is a large mileage of surface inadequate for present civilian traffic. In the study of the condition of the 80,000-mile strategic system, described in another article in this issue, preliminary examination of some of the reports received from the states indicate that more than 90 per cent of the system is hard surfaced. The remainder consists of gravel or types inferior to gravel. This latter mileage should be hard surfaced as rapidly as possible, and it will probably be desirable to improve and modernize a considerable mileage of the existing hard surfaces.

The proposed interregional system includes the more heavily traveled and most important routes included in the more extensive strategic system, and for that reason its condition is indicative of the best conditions we may expect to find on the strategic system. Fig. 4 presents a condition summary of the total tentatively selected interregional system in relation to traffic volume and shows that the entire mileage is hard surfaced, approximately in equal amounts with rigid and non-rigid types, and that the proportion of rigid pavement increases steadily with traffic volume.

In the matter of roadway width and alignment the dimensions of military vehicles, with a few exceptions, are not critical, but speed and traffic volume may be. In this respect, much of our present mileage falls far short of reasonably adequate standards, for we must anticipate the sudden imposition of a considerable volume of high-speed military traffic on any part of the strategic system and the simultaneous necessity of maintaining essential civilian transport.

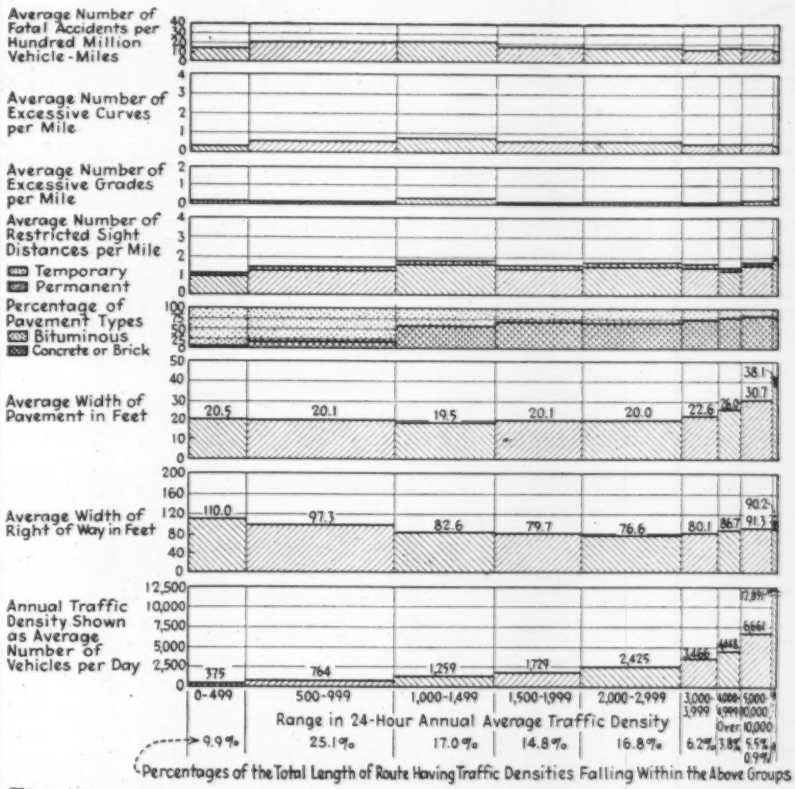


Fig. 4. To pick out the sore spots, the physical condition of the 30,000-mile interregional road system was charted by traffic volume groups.

The chart in Fig. 4 also shows that 83.6 per cent of the mileage, carrying less than 3,000 vehicles per day, averages only slightly more than 20 ft. in width. On the basis of preliminary field studies ("A Study of Passing of Vehicles on Highways," *Public Roads*, September, 1937, Vol. 18, No. 7) it has been generally agreed that 18-ft. surfaces are inadequate for modern traffic; that 20-ft. surfaces are reasonably adequate for roads used infrequently by vehicles of large dimensions; and that 22-ft. surfaces are adequate. This applies to 2-lane tangents. Preliminary results of more recent and exhaustive studies of highway capacity by the Public Roads Administration indicate that highway capacity is a function not only of traffic volume but of traffic fluctuations and that these fluctuations may justify the widening of 2-lane roads carrying as low as 2,000 vehicles on an annual average 24-hr. day.

Preliminary standards

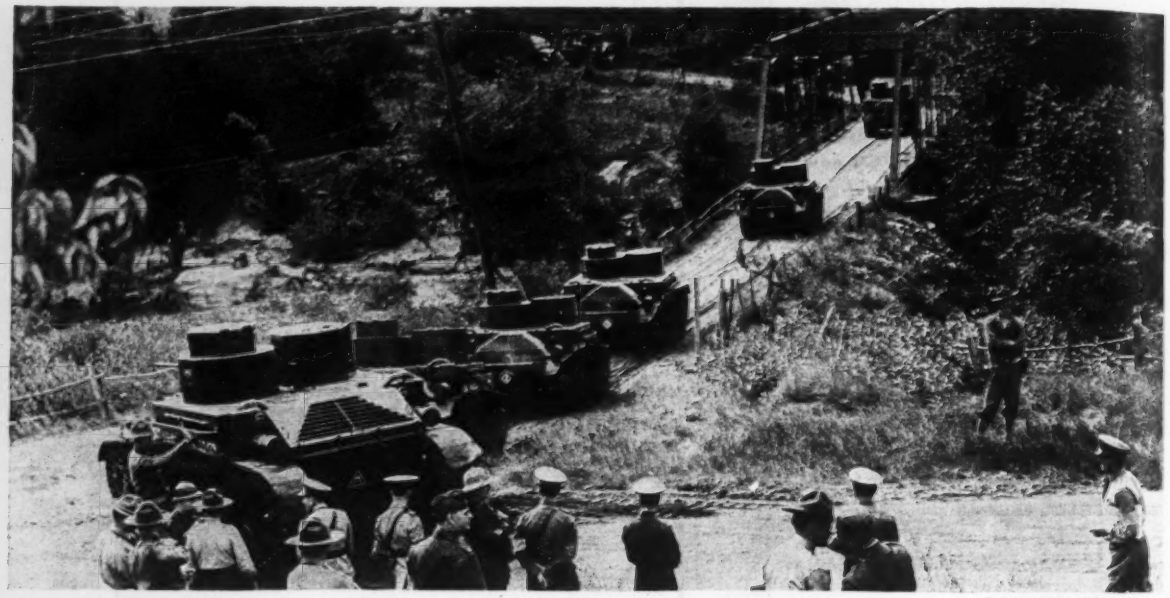
Detailed field and office studies are now under way in an effort to establish desirable minimum width, sight distance, grade, and curvature standards, but sufficient results are not yet available to estimate these desirable standards with certainty. However, in making an inventory of critical alignment on main highways, the cooperative highway planning surveys established the following limits, all features exceeding these limits being recorded:

Sight distance
- 1,000 ft. in non-mountainous terrain
- 650 ft. in mountainous terrain

Curvature
- 6 deg. in non-mountainous terrain
- 14 deg. in mountainous terrain

Grades
- 5 per cent for distances exceeding 500 ft. in non-mountainous terrain
- 8 per cent for distances exceeding 500 ft. in mountainous terrain

In Fig. 4, the charts for excessive curves and grades include places exceeding these limits. Accordingly, these "sore spots" are not necessarily all sub-standard, no standards in the strict sense having yet been determined. But when it is considered that these limits are not unduly high nor widely divergent from current practice, and that the interregional system represents the most important of our principal intercity roads, it seems safe to predict that much of the 80,000-mile system will require improvement.



International News Photo

FIG. 1. "WARNING, 10 TONS SAFE LOAD" SAYS A SIGN, SO THE TANKS TAKE THIS INADEQUATE BRIDGE ONE AT A TIME.

Highway Bridges Under Wartime Loads

G. S. PAXSON

Bridge Engineer, Oregon State Highway Department, Salem, Ore.

Contents in Brief—Military vehicle loads are no more severe than those of commercial vehicles, and, although heavy truck-and-trailer units with closely spaced axles cause overstress, the modern H-15 bridge is adequate. But there are 20,000 substandard bridges, too light, too narrow or lacking in vertical clearance, that need to be replaced at a cost of $400,000,000.

ANY DISCUSSION of highway bridges and in particular their service under wartime transport must logically start with an examination of the condition of the existing bridges. Highway bridge design before the advent of the motor truck and during the early years of motor-driven transport development was, in the main, based on the horse-drawn vehicle. The heaviest loads that could reasonably be anticipated were the steam-driven traction engines. The structures of that day were adequate for such loads but fell far short of meeting growing needs, so that a rebuilding of practically all highway bridges became necessary. This rebuilding has been going on for the last two decades, but twenty years is too short a time to complete the job. We thus find upon the highway system two classes of bridges: The relics of the "horse and buggy" era, designed for light loads and generally with narrow roadways, and the so-called modern bridge, built to carry the motor truck.

The substandard bridges of the first class must now be replaced, and those that are links in highways of military importance should have priority in the program of construction. It is comforting to note that accredited representatives of the War Department assure us that highways necessary for peace-time needs will, in general, be those required for war transport.

Bridges lag behind roads

Bridges are the most expensive part of the highway system when measured in terms of length. In the past when a choice has had to be made between improving several miles of inadequate road or of rebuilding a few hundred feet of bridge, the road has usually been preferred. This natural desire for the greatest service from the limited money available largely accounts for the great number of substandard bridges scattered over otherwise adequate highways, causing these highways to be operated through traffic controls which limit loads and require the routing of the heavier vehicles over other roads capable of carrying them. These conditions, uneconomical in peace time, would be intolerable under the demands of war transport.

With half the world at war, the examples of the importance of an adequate transportation system have focussed attention upon this weakest link in our highways. The majority of the state highway organizations have detailed data on the substandard structures on the important roads and, through the Public Roads Administration, these data are being assembled into a comprehensive sur-

vey (as indicated on page 85) which will show the deficiencies and serve as a basis for intelligent programming of reconstruction.

A preliminary compilation of the data at hand indicates that there are approximately 20,000 substandard bridges on the main routes of our state highway system that should be widened or rebuilt. It is estimated that the cost of this work will be roughly $400,000,000. This is a large order, even for this nation, and will not be accomplished immediately. The need for an orderly program in which the federal government cooperates as a national defense measure is apparent.

Standard loadings

The standardization of highway bridge design dates back to the Federal Highway Act of 1916; and by 1919 the federal government was cooperating in a large proportion of the highway projects. With this cooperation went a supervision and coordination that standardized the loading requirements in terms of a motor truck. The weight of truck used varied from 10 to 20 tons, but for main highway structures a 15-ton truck was considered as a minimum loading. In the fall of 1921 the American Association of State Highway Officials, recognizing the importance of a nation-wide structural standard appointed a committee on bridges and structures under the chairmanship of E. F. Kelley, now chief of the division of tests, Public Roads Administration. In 1923 this committee proposed a tentative bridge specification in which the so-called "H" loadings were given.

These H-loadings contemplate a truck of total weight equal to the H-loading in question (H-15 loading uses a truck weighing 15 tons) followed and preceded by a line of trucks, each having a gross weight of three-fourths of the indicated loading class.

The tentative bridge specification came into almost immediate use and developed into the specification adopted by the association and published in 1931. The specification is a living thing that is continually undergoing refinement and development, but the wisdom of the adoption of the H-loadings is evidenced by the fact that they are still in use today and still adequate for the changing traffic. The A.A.S.H.O. committee, first under the leadership of Mr. Kelley and, from 1928 until his death last month, with Albin L. Gemeny as chairman, has continued the work of keeping the specifications modern.

When the H-loadings were devised, neither the close-coupled semi-trailer nor the truck-tractor and four-wheeled trailer was in common use. Although individual axle loads are generally restricted to 18,000 lb. as a protection for the highway pavements, controlling stresses in bridges are rarely produced by individual axle loads but are the result of this grouping of the multiple axles.

Military vehicle loads

The War Department in the design of military equipment has wisely conformed to the general standard set by the commercial equipment for which the existing modern highway bridges have been designed. A comparison of the loadings of typical War Department equipment and the standard H-15 loading is given in Fig. 2. It will be noted that the requirements for ordnance are less than for the standard loading. The Air Corps wrecking truck, on the other hand, is of the semi-trailer type, comparable in every way with present heavy-duty commercial vehicles, which overstress structures designed to H-15 specifications.

The gross weight and the relationship between gross weight and out-to-out axle spacing will generally be controlling in the case of chord stresses in truss bridges, and may also produce controlling stresses in the web systems although the stresses in these latter members will be influenced to a certain extent by the axle group concentrations within the vehicular train.

In the case of modern heavy transport units, there is a third factor which is far more apt to be controlling. This is the concentration of axle loads in a compact group near the midsection of the vehicular train. This controlling concentration is usually made up of the dual axles of the truck and the front axle of the trailer. Its effect is influenced by the spacing of the axles, and the closer the spacing the greater will be the resulting stresses.

Critical types of loads

The axle loads and axle spacings in truck and trailer combinations vary with each type of equipment, but a typical load diagram of a truck and four-axle trailer is shown at the top of Fig. 3. To study the effect of such a vehicular train with reasonable following and preceding loads, the loading was applied to existing, modern H-15 bridges of varying type and span length. The overstress re-

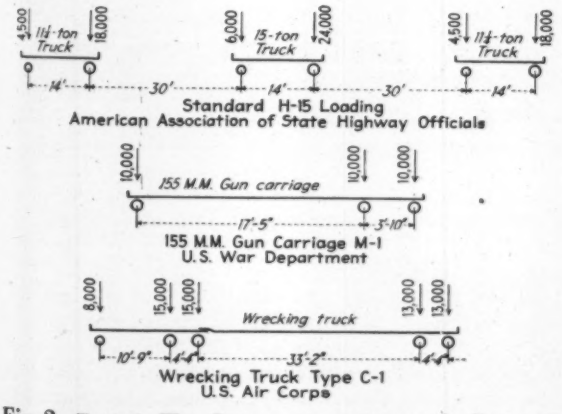


Fig. 2. Typical War Department equipment loading compared with the standard H-15 truck train loading.

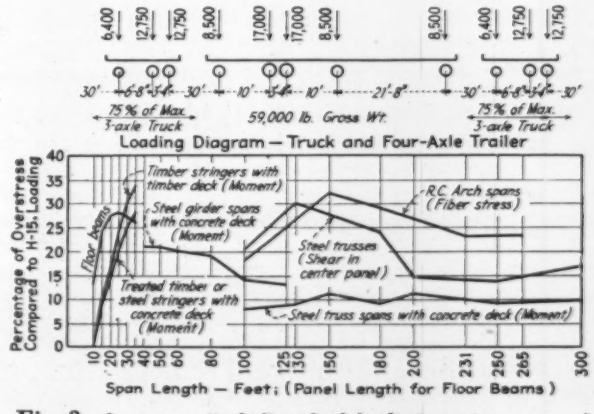
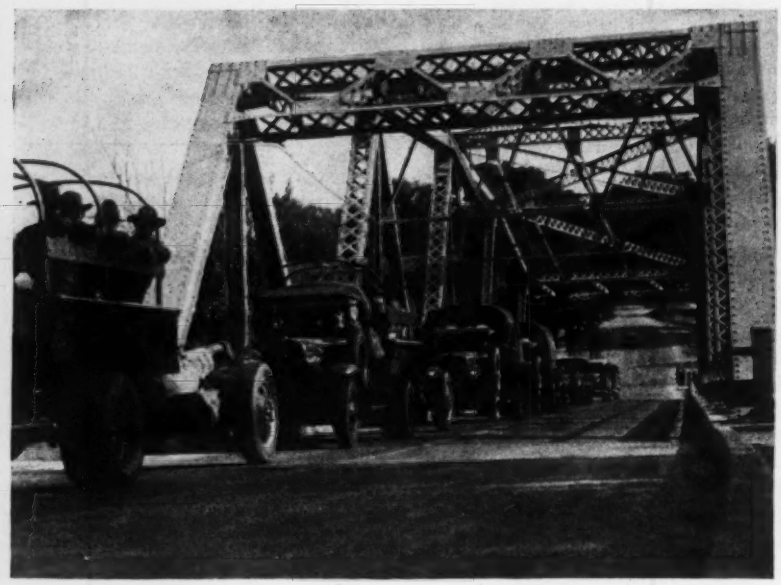


Fig. 3. Overstress (including dead load) in various types of H-15 bridges caused by a truck-and-trailer unit as shown.



U. S. Army Signal Corps. Photo

Fig. 4. A bridge that "has what it takes" to serve wartime traffic, namely strength, width and headroom.

sulting from this load application is shown in the lower part of Fig. 3.

The total stress in the structure is, of course, the combination of the stress from its own dead load and the stress from the applied live load. Since the dead load stress remains constant, the total stress does not increase at the same rate as the increased live load. The ratio of dead load stress to live load stress in the design will also be reflected in the overstress from the heavier load. No two structures of the same span length and general type of design will show exactly the same overstress under the heavier load. In general, however, the overstresses shown are approximately those that should be expected in H-15 bridges under the loading indicated.

The overstresses shown in Fig. 3 reach a maximum of 34 per cent in the case of timber trestles with timber stringers and timber deck, which is to be expected since the ratio of dead load to live load is less with timber construction than with any other material. The overstress of 32 per cent shown for the 150-ft. concrete arch span is due to the close spacing of the spandrel columns supporting the floor system and the resulting concentration of the column loads from the close-spaced axles.

In general, the most serious overstresses are produced in spans long enough to contain the close group of heavy axles but not long enough to get the benefit of the lighter loads and wider spacings of the loads assumed to follow and precede the heavy unit. As the spans increase in length, the ratio of dead load to live load increases and the percentage of overstress decreases. Except for floorbeams and stringers, the overstress in the members of long-span structures is not serious.

War transport is to a large extent controlled traffic. The spacing and arrangement of vehicles in a convoy can be so ordered that two or more vehicles, comparable to the vehicle assumed in this investigation, will not follow without adequate space between them. Since no such control is practicable with commercial vehicles, the fact that H-15 structures are carrying this type of traffic is evidence of their adequacy for war transport needs.

Inadequate clearances common

The situation with regard to roadway widths and vertical clearances is not so favorable. Many of the earlier bridges which are adequate in load-carrying capacity have narrow roadways. When they were built, 16 and 18 ft. were standard pavement widths, and, with the relatively slow-moving traffic, 18- and 20-ft. bridge roadways were considered ample. The widening of the approach pavements, because of the ease with which such work can usually be done, has for the most part been accomplished. The widening of the bridges, often involving almost complete reconstruction, has been deferred due to the pressing need for important extensions of the system. For the past several years, 24 and 26 ft. have been the usual widths for 2-lane bridges.

Vertical clearances have usually been adequate except at the sides of the roadway where earlier specifications permitted portal and sway bracing to encroach. Since 1935 the A.A.S.H.O. specifications have required a vertical clearance of 14 ft. over the entire roadway. The rebuilding of portal and sway bracing is not a costly procedure with the welding equipment now available, and many of the older bridges have now been altered to provide full clearance over the entire roadway.

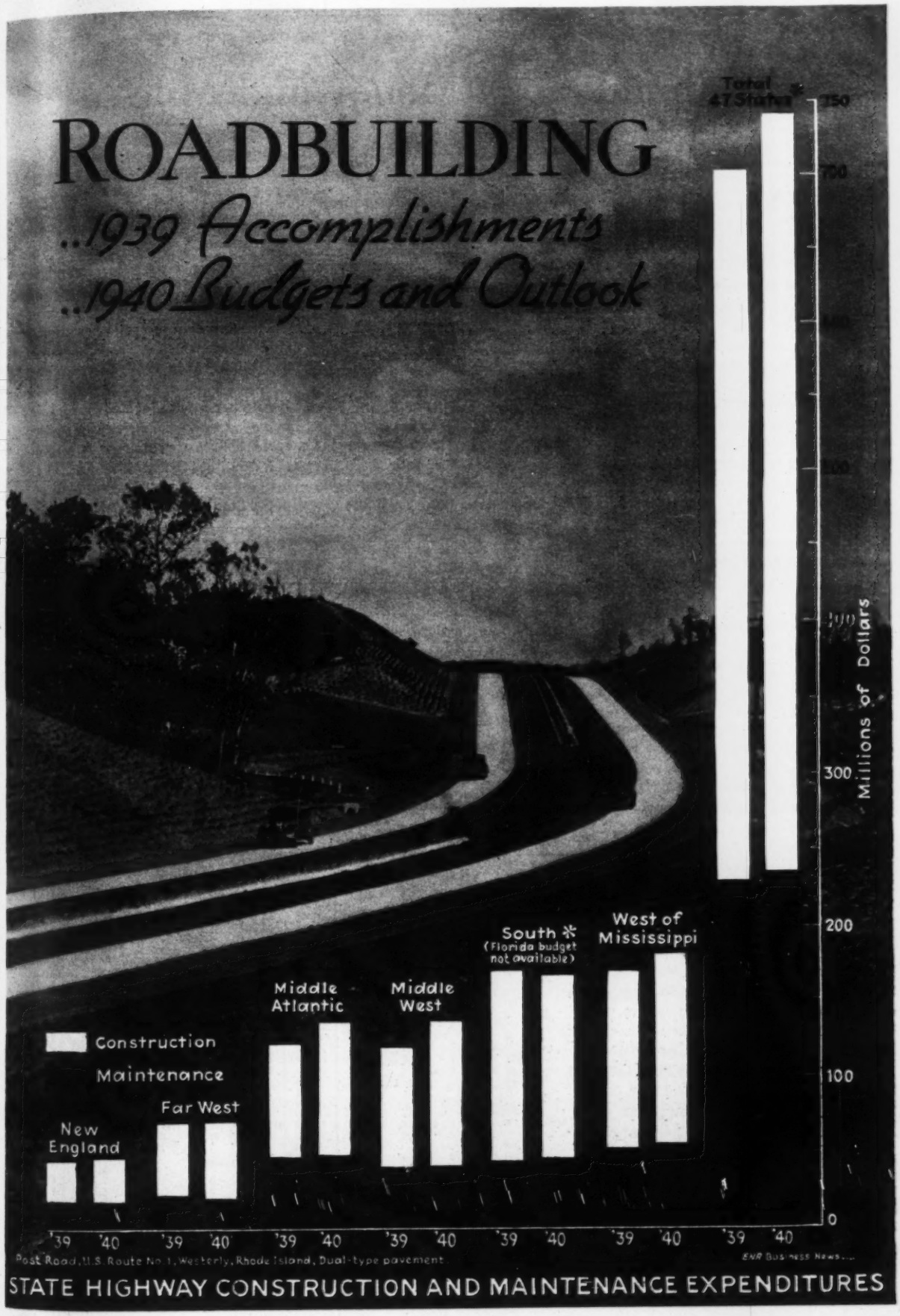
Conclusions

In general, the question of the adequacy of bridges to meet the needs of war transport can be answered as follows:

There are on the main routes of the state highway system approximately 20,000 substandard bridges that by reason of light design, narrow roadway, or restricted vertical clearance, are not adequate for efficient military transport. The detailed data concerning these structures are available or can be obtained by the state highway departments and should be developed in cooperation with the Public Roads Administration into a logical basis for an intensive program of reconstruction. The importance of the various routes from the standpoint of war transport should be given consideration in the formulation of the reconstruction program.

The standard H-15 loading now in universal use throughout the nation is adequate for the ordinary needs of war transport. The exceptional war transport load is comparable to the heavier commercial vehicles now operating over the highways. While such vehicles do produce overstresses, the magnitude of the overstress is not such as to endanger the structure.

The thousands of structures built in accordance with the H-15 specification at a cost of many hundreds of millions of dollars and the impracticability of increasing their load-carrying capacity without expensive reconstruction make it advisable for the War Department to continue its present policy of designing equipment to conform with this standard.


ROADBUILDING
..1939 Accomplishments
..1940 Budgets and Outlook
Total 47 States*
750
700
500
300
200
100
0
Millions of Dollars
Construction
Maintenance
New England
Far West
Middle Atlantic
Middle West
South *
(Florida budget not available)
West of Mississippi
'39 '40 '39 '40 '39 '40 '39 '40 '39 '40 '39 '40 '39 '40
Post Road, U.S. Route No 1, Westerly, Rhode Island, Dual-type pavement
ENR Business News...
STATE HIGHWAY CONSTRUCTION AND MAINTENANCE EXPENDITURES

Roadbuilding in Money and Miles

***Contents in Brief**—In 1939 the 48 states invested two-thirds of their highway money in new construction and one-third in maintenance and equipment. With $485,924,000, they improved 30,428 miles of road, of which 9.4 per cent is hard-surfaced, and 52.4 per cent bituminous while 38.2 per cent is graded and drained without treated surfacing. Early budgets for 1940 indicate, without allowing for possible increases for defense roads, that state highway construction will be 6 per cent greater than in 1939. Federal legislation will be of unusual interest.*

PRELIMINARY ESTIMATES by the 48 state highway departments of their expenditures for 1939 total $719,262,000, compared with $734,646,000 in 1938. Two significant qualities of highway management, are revealed in these two figures: the stability of the nation's highway improvement program and the remarkably close budgeting of expenditures that state highway departments have achieved. In the annual highway issue last year *Engineering News-Record* published 1939 budgets for 40 states and predicted (March 2, 1939) that 1939 highway expenditures would be "only 2 per cent below 1938 expenditures." The preliminary estimates for 48 states reported herewith show that state highway expenditures for 1939 are in fact just 2 per cent below corresponding 1938 expenditures.

New construction continues to take two-thirds and maintenance one-third of the state expenditures; in 1939 $485,924,000 for new construction, $233,338,000 for maintenance and equipment.

Of the new construction money the South spent $139,163,000, or 28.8 per cent; West of Mississippi states, $117,382,000, or 24.2 per cent; Middle West, $79,981,000, or 16.4 per cent; Middle Atlantic, $75,399,000, or 15.5 per cent; Far West, $48,053,000, or 9.9 per cent; and New England, $25,946,000, or 5.3 per cent.

Maintenance expenditures in each territory for 1939, with percentage of the national volume are: West of Mississippi, $53,420,000, or 22.9 per cent; Middle Atlantic, $48,479,000, or 20.8 per cent; South, $48,382,000 or 20.7 per cent; Middle West, $41,104,000, or 17.6 per cent; Far West, $22,876,000, or 9.8 per cent; and New England, $19,077,000, or 8.1 per cent.

Thus, New England reports the highest maintenance ratio, 42 per cent of combined new construction and maintenance funds; Middle Atlantic is next with 39 per cent; then Middle West with 34 per cent. Below the national average are West of Mississippi, 31 per cent; and South, 26 per cent. Far West with 32 per cent hit the national average on the nose.

This maintenance ratio has climbed since 1936, when it was 27 per cent, to 29 per cent in 1937, 33 per cent in 1938, 32.4 per cent for 1939.

Another way to look at the highway money is that each American in 1939 spent $5.80, of which $3.97 was for new road construction and $1.83 for maintenance. Per capita expenditures in the South and West are higher than

I—HIGHWAY CONSTRUCTION RECORDS FOR 48 STATES

States	Mileage Constructed in 1939				Expenditures—1939 (,000 omitted)			Expenditure Budget—1940 (,000 omitted)		
	Total	Hard Surface	Bituminous Types	Graded & Drained	Total Const. & Maint.	Construction	Maint. & Equipment	Total Const.[1] & Maint.	Construction	Maint. & Equipment
Me.	330	6	287	37	$9,821	$5,905[1]	$3,916[2]	$9,870	$6,200	$3,670
N. H.	87	9	70	8	5,747	2,134	3,613	5,320	1,960	3,360
Vt.	53.8	2.9	50.9	.....	6,000	4,000	2,000	6,000	4,000	2,000
Mass.	59	3	50	6	7,851	2,384	5,467	6,603	1,294	5,309
R. I.	17	11	6	.....	2,354	1,423	931	3,000	1,750	1,250
Conn.	57.3	36.3	15.6	5.4	13,250	10,100	3,150	13,936	9,863	4,073
New Eng.	**604.1**	**68.2**	**479.5**	**56.4**	**$45,023**	**$25,946**	**$19,077**	**$44,729**	**$25,067**	**$19,662**
N. Y.	266	210	40	16	$29,300	$19,500	$9,800	$48,050	$37,550	$10,500
N. J.	57	24[3]	.....	33[3]	16,965	13,285	3,680	11,317	7,717	3,600
Pa.	550	150	300	100	55,500	25,000	30,500	55,500	25,000	30,500
Md.	129.8	41.7	44.7	43.4	19,478	16,022[4]	3,456	21,208	17,264[4]	3,944
Del.	158.2	24.6[5]	105.0	28.6	2,635	1,592	1,043	2,240	1,250	990
Mid. Atl.	**1,161.0**	**450.3**	**489.7**	**221.0**	**$123,878**	**$75,399**	**$48,479**	**$138,315**	**$88,781**	**$49,534**
Va.	701.3	53.9[6]	483.5[6]	163.9	$24,166	$19,166	$5,000	$25,932	$20,332	$5,600
W. Va.	1,475.6	36.0	1,202.9	236.7	16,025	10,100	5,925	15,800	10,000	5,800
N. C.	2,012	204[7]	818[7]	990	28,455	15,430	13,025	26,720	13,500	13,220
S. C.	300	36[8]	231[8]	33[8]	10,963	8,000	2,963	9,450	6,500	2,950
Ga.	1,010	40	370	600	16,909	12,406	4,503	16,500	13,000	3,500
Fla.	408.5	15.7	251.1	141.7	16,627	13,183	3,444	4,499[9]	.....	4,499
Ala.	3,318	8[4]	1,929	1,381	13,380	11,304	2,076	13,300	11,300	2,000
Miss.	716.3	287.7	166.8	261.8	25,272	23,429	1,843	13,650	12,000	1,650
La.	342	51	33	258	13,912	11,574	2,338	18,587	14,987	3,600
Ky.[10]	428	74	79	275	11,136	7,271	3,865	14,500	9,000	5,500
Tenn.[10]	204.5[4]	84	12	108.5	10,700	7,300	3,400	13,200	9,800	3,400
South.	**10,916.2**	**890.3**	**5,576.3**	**4,449.6**	**$187,545**	**$139,163**	**$48,382**	**$172,138**	**$120,419**	**$51,719**
Ohio	1,780	353	1,396	31	$35,105	$22,000	$13,105	$36,625	$23,000	$13,625
Ind.	518	104	376[11]	38	25,493	15,981	9,514	27,115	19,533	7,582
Ill.	568.5	177.2	211.3	180.0	25,985	20,000	5,985	39,206	31,306	7,900
Wis.	439	142	195	102	14,000	8,500	5,500	14,000	8,500	5,500
Mich.	425	63	240	122	20,500	13,500	7,000[12]	22,000	15,000	7,000[12]
Mid. West.	**3,730.5**	**839.2**	**2,418.3**	**473.0**	**$121,085**	**$79,981**	**$41,104**	**$138,946**	**$97,339**	**$41,607**
Minn.	839.5	17.5	241.7	280.3	$14,282	$7,805	$6,477	$19,510	$11,301	$8,209
Iowa	576.5	142.5	107.0	327.0	14,108	10,283	3,825	15,303	11,300	4,003
Mo.	501.5	69.1	128.8	303.6	13,750	7,550	6,200	17,003	10,800	6,203
Ark.	167	18	85	64	6,751	3,406	3,345	6,845	3,503	3,343
N. D.	295	.....	295	.....	4,464	3,080	1,384	4,356	2,770	1,586
S. D.	475.8	25.6	283.2	167.0	6,245	4,000	2,245	6,275	4,003	2,275
Neb.	1,133	23	302	808	9,900	6,900	3,000	9,900	6,900	3,000
Kan.	576.3	23.6	184.4	368.3	10,513	6,850	3,663	13,100	8,600	4,500
Okla.	421.1	39.7	189.9	191.5	14,700	10,400	4,300[13]	16,500	12,000	4,500[13]
Tex.	3,281.3	190.1	1,152.0	1,939.2	46,889	34,172	12,717	46,889	34,172	12,717
Mont.	351	.....	136	215	8,300	6,200	2,100	7,200	5,100	2,100
Wyo.	530	.....	400	130	4,451	3,700	751	4,450	3,700	750
Colo.	871	.....	630	241	9,450	7,950	1,500	7,250	5,750	1,500
N. M.	566	.....	269	297	6,999	5,086	1,913	6,850	5,000	1,850
W. of Miss.	**10,285.0**	**549.1**	**4,404.0**	**5,331.9**	**$170,802**	**$117,382**	**$53,420**	**$181,425**	**$124,893**	**$56,532**
Idaho	241.5	3.3	116.0	122.2	$5,568	$3,900	$1,668	$5,772	$4,022	$1,750
Utah	413	12	226	175	5,880	4,500	1,360	5,520	3,800	1,720
Ariz.	253.5	9.2	215.4	28.9	6,097	4,666	1,431	6,915	5,500	1,415
Nev.	180.2	.....	149.0	31.2	3,670	2,800	870	4,400	3,500	900
Wash.	970	13	677	280	11,099	7,342	3,757	11,830	7,725	4,105[6]
Ore.	840	.....	420	420	9,770	6,100	3,670	10,650	6,500	4,150
Calif.	833	31.6	783.0	18.4	28,865	18,745	10,120[14]	25,031	18,083	6,948[14]
Far West.	**3,731.2**	**69.1**	**2,586.4**	**1,075.7**	**$70,929**	**$48,053**	**$22,876**	**$70,118**	**$49,130**	**$20,988**
U. S.	**30,428.0**	**2,866.2**	**15,954.2**	**11,607.6**	**$719,262**	**$485,924**	**$233,338**	**$745,671**	**$505,629**	**$240,042**

1. Includes bridges and grade crossings. 2. Includes snow removal. 3. Includes widening, 6 mi. hard surface; 15 mi. graded and drained. 4. Includes bridges. 5. Includes 7.4 mi. 20-ft. hard surface widening. 6. Includes widening, 43.6 mi. hard surface; 40.3 mi. bituminous. 7. Includes widening. 8. Estimated on basis of 1938 data. 9. Maintenance only. 10. 11 months 1939. 11. Includes 239 mi. rock asphalt paving. 12. Includes traffic service. 13. Includes administration. 14. Includes maintenance and operation of San Francisco-Oakland Bay Bridge.

the national average, as is to be expected. By regions they are: South, $7.35; Far West, $7.33; West of Mississippi, $6.46; New England, $5.51; Middle West, $4.79; and Middle Atlantic, $4.33.

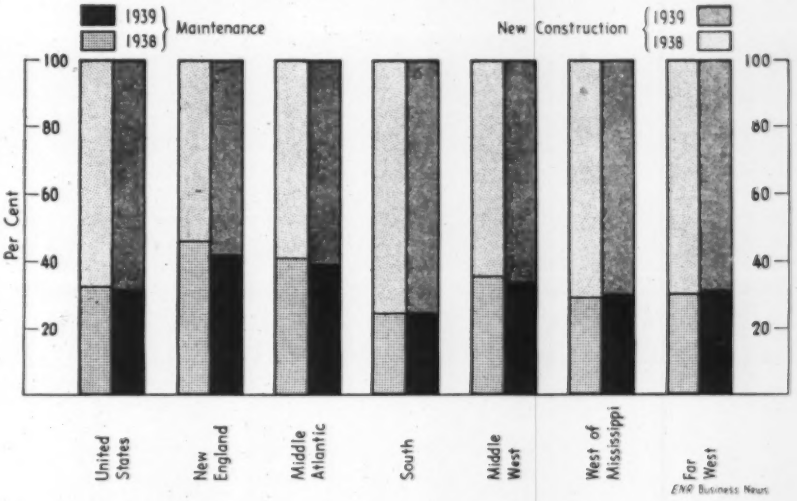
For maintenance alone, Far West is highest at $2.36 per capita, New England second at $2.34, followed by South at $1.86, all above the national average; and by West of Mississippi, $1.90; Middle Atlantic, $1.70; and Middle West, $1.63, all below the national average.

Types of surfacing

Again bituminous types of surfacing lead the year's mileage reports. Altogether, in 1939, state highway departments built 30,428 mi. of improved surfacing of which 2,866 mi. or 9.4 per cent is hard pavement, 15,954 mi., or 52.4 per cent, is bituminous; and 11,608 mi., or 38.2 per cent is graded and drained or improved with untreated surfacing. Compared with the estimated mileages constructed in 1938, this is an increase of 7.4 per cent in total mileage improved, a drop of 18 per cent in hard surfacing, an increase of 7 per cent in bituminous types, and a gain of 18 per cent in untreated surfacing and graded and drained mileage.

Hard surfacing practice varies in different sections of the country.

RATIO OF CONSTRUCTION TO MAINTENANCE EXPENDITURES



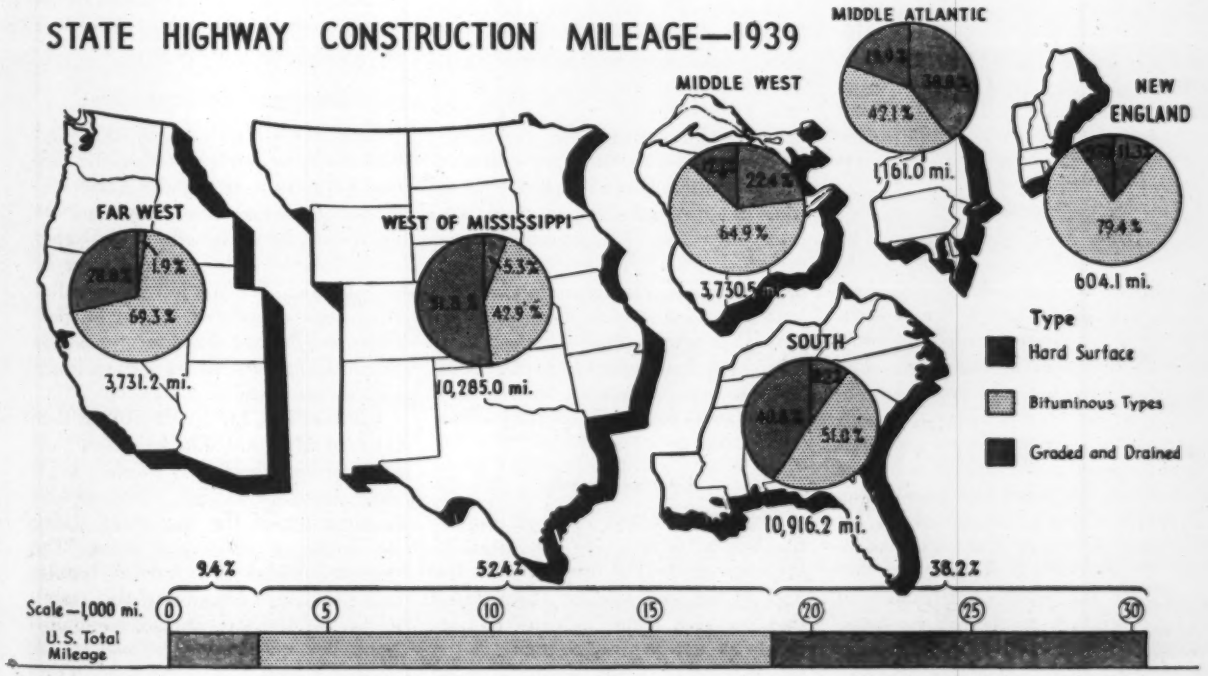
Middle Atlantic states put 38.8 per cent of their 1939 mileage into 450 mi. of hard surfacing; Middle West states, 22.4 per cent into 839 mi.; Southern states, 8.2 per cent into 890 mi.; Far West states, 1.9 per cent into 69.1 mi.; New England, 11.3 per cent into 68.2 mi.; and West of Mississippi states, 5.3 per cent into 549 mi. of hard surfacing.

New England selected bituminous types of surfacing for 480 mi. or 79.4 per cent of its mileage; Far West, 2,586 mi., or 69.3 per cent; Middle West, 2,418 mi., or 64.9 per cent; all above the national average. South, with 5,576 mi., or 51 per cent; West of Mississippi states with 4,404 mi., or 42.9 per cent; and Middle Atlantic states with 490 mi., or 42.1 per cent. are below the average percentage of bituminous mileage built in 1939.

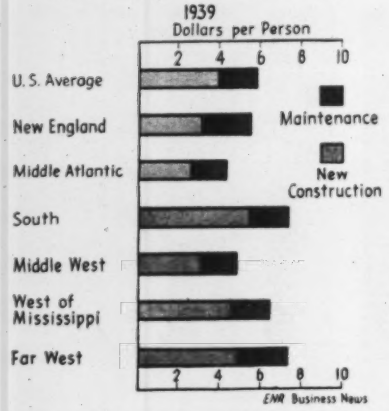
1940 budgets increase

Budgets for 47 states predict for 1940 a 6 per cent increase over state highway expenditures reported for 1939, and this gain is in spite of the cut in federal aid and does not take into account possible increased federal expenditures for defense highways.

STATE HIGHWAY CONSTRUCTION MILEAGE—1939



PER CAPITA EXPENDITURES THROUGH STATE HIGHWAY DEPARTMENTS FOR CONSTRUCTION AND MAINTENANCE



The 40 states which reported budgets last year (*ENR*, March 2, 1939) expected to spend $596,946,000 in 1939. Their actual 1939 expenditures reported this year are $605,236,000, only 1½ per cent over their budgets, remarkably close planning.

In 1940, 47 states expect to spend $741,172,000 (Florida budget missing). Of this total $505,629,000 is for new construction, a gain of 6 per cent over 1939, and $235,443,000 is set aside for maintenance and equipment, a projected increase of 2.5 per cent over last year.

The Middle West is budgeting a 15 per cent increase over 1939, and Middle Atlantic and West of Mississippi 12 and 6 per cent gains. Southern states report a 2 per cent decrease. New England and Far West both expect a 1 per cent decline in 1940 as compared with 1939.

For new construction, exclusive of maintenance, West of Mississippi states are budgeting $124,893,000, 6 per cent higher than in the previous year; Middle West, $97,339,000, up 22 per cent; Middle Atlantic, $88,781,000, up 18 per cent; and Far West, $49,130,000, up 2 per cent. New England and Southern construction budgets are 3 and 4 per cent lower than last year.

These budgets are based on Federal aid of $135,000,000—$100,000,000 for primary roads, $15,000,000 for secondary and $20,000,000 for grade crossings.

What Congress Plans To Do On Roads

Every even-numbered year Congress must decide federal road policy for the next two years when it acts on the biennial highway authorization bill. This year the bill comes up at a time when the country and Congress are receptive to expenditures having a legitimate connection with national defense, and it presents the first opportunity for Congress to act on the searching examination of road policy made by the Public Roads Administration in its superhighway report of last Spring.

The authorization bill introduced in the first days of the session by Senator Carl Hayden of the Senate committee on post offices and post roads and Chairman Wilburn Cartwright of the House roads committee consists this year of two parts. The first continues, substantially unchanged, the present federal aid arrangement, while the second part would set up a new system of loans to aid in acquisition of rights-of-way for express roads through cities. Although this is now the only innovation in the bill, it is possible that provision for some construction of strictly military roads will be introduced later.

As introduced, the bill leaves the amounts of federal aid blank, but several factors lead Senator Hayden to believe that the figures finally settled on will be substantially higher than those for the current year.

Because of large amounts of emergency money available in past years, many states have not matched their full federal aid allocations, and existence of this unused money has made it difficult to ask Congress for larger authorizations. Preliminary estimates by the Public Roads Administration indicate that this situation has now been corrected. The Senator hopes, therefore, that the amounts finally approved will come close to the 1936 authorizations, which he regards as normal, when $125,000,000 was approved for primary roads, $25,000,000 for secondary roads, and $50,000,000 for grade-crossing elimination.

Express roads

The new express road section of the bill is, with slight modification, the same as the bill introduced at the end of the last session. Introduced then to give state highway departments an opportunity to study it, the bill authorized PRA to buy rights-of-way for highway facilities and resell them, over a 40-year period, to states or local governments. Such a procedure is based on PRA's recommendation that express roads through cities are the present major highway need and that financial and legal difficulties in land acquisition are the chief obstacles. It fits in also with the feeling in Army circles that easy truck movement in metropolitan areas is a major preparedness need.

Highway department reaction to the plan is said to have been uniformly favorable. The only suggestion received has been incorporated in the bill, that approval of the state highway department be required before any land is bought for a city or county.

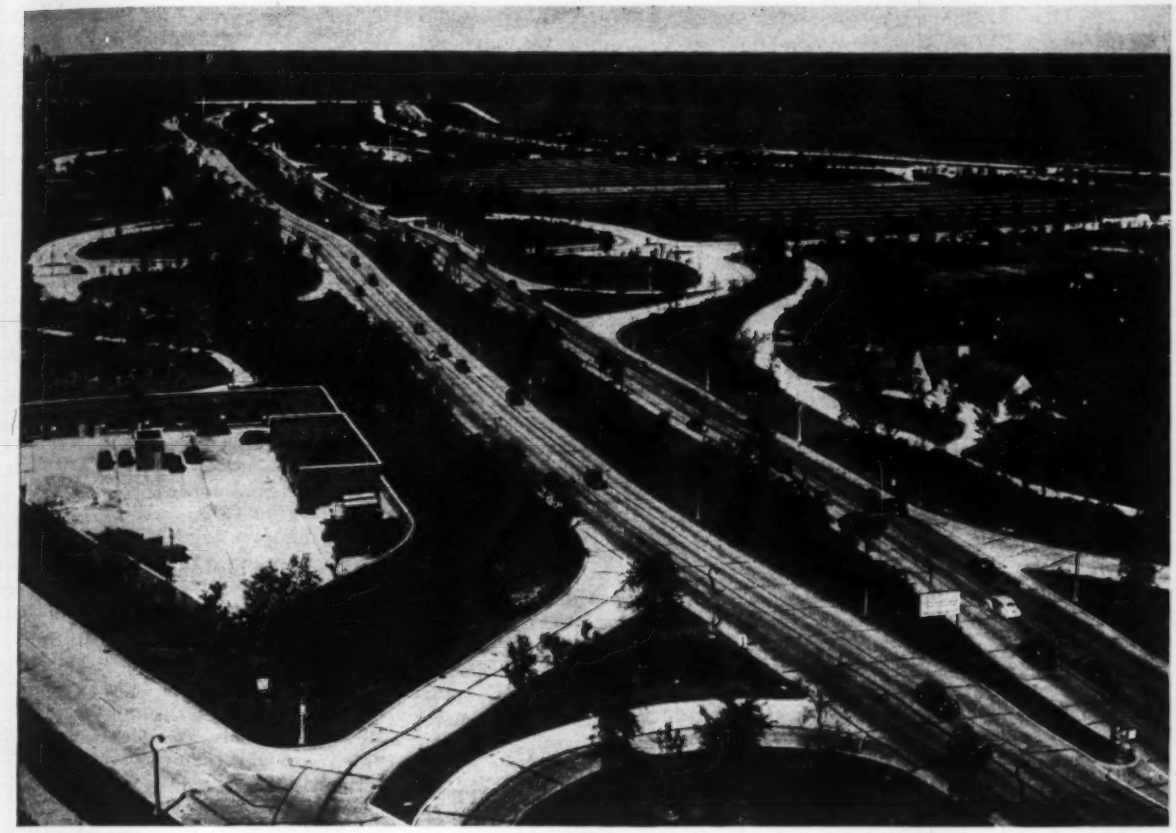
Military roads

Not included in the bill as introduced but likely to come up for consideration is the question of financing purely military roads. Some provision will have to be made for providing highway service to military reservations and concentration points, often in remote localities, and for rerouting state roads now on the sites of proposed air bases or reservations. Present plans do not contemplate direct federal construction, as in national parks, but instead would provide PRA with a fund from which it could allocate to state highway departments all or part of the cost of the military roads. The size of such a fund is still being studied.

Inter-regional highways

Realistic studies of a Washington-Boston interregional highway are now being initiated by the states concerned in cooperation with the Public Roads Administration, and other major routes will doubtless soon be investigated. When a few such studies have been completed it will be possible to bring definite proposals before Congress. No legislation is expected this year.

The outlook for roadbuilding thus is unusually good. The healthful gain of 6 per cent, budgeted by state highway departments for 1940 assures continuance of the important stability achieved in recent years. The present outlook for federal legislation promises extension of this stability of the highway improvement program beyond 1940.



CITY DEVELOPMENT OF HIGHWAY OUTLETS IS REPRESENTED BY THIS SECTION OF LAKE SHORE DRIVE IN CHICAGO.

Road Plans and Expenditures

***Contents in Brief**—Roads built and money spent on highways in 1939 are given as reported by state highway engineers in all the states of the Union. Anticipated highway expenditures for 1940 are given for 47 of the 48 states. Also given for most states are brief official statements of trends in highway administration, design and construction.*

New England States

New Hampshire looks to safety

The elimination of dangerous sections of highway caused by poor alignment, of steep grades; of narrow, high-crowned road sections and inadequate bridges; also the replacement of worn-out sections of road that have shown excessive maintenance costs, marked the state highway department's 1939 trunk line reconstruction program, states highway commissioner F. E. Everett. Particular attention has been given in new construction to the incorporation of such features of road design as will furnish the maximum degree of safety to the motorist, taking into consideration the volume and nature of traffic. Adherence to this policy has resulted in increasing the width of pavements on the main trunk lines from 20 ft. to 22 or 24 ft. Deep drainage ditches have been eliminated; drainage structures incorporated into the design in such a manner as to reduce to the minimum traffic obstructions, and widened sections have been used when economical to eliminate the use of guard rail. A study of the native foundation is made for each new project. The information provided by such a study permits an economical foundation design and provides the best method for correcting dangerous frost areas during the construction period. The figures for 1939 and 1940 are:

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	9
Bituminous types (including surface treated stabilised bases)	70
Graded and drained (including gravel or other untreated mineral surfaces)	8
Total mileage constructed in 1939	87

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$2,133,869	$1,960,400
Maintenance	3,578,748	3,330,000
Equipment	34,300	30,000
Total	5,746,917	5,320,400

Rhode Island builds dual roads

G. H. Henderson, state highway engineer, states that the department has continued its policy of constructing four-lane pavements, with outside lanes

Mountain roadbuilding presents a picturesque example in the revamped Colorado highway crossing the Rockies at Monarch Pass at El. 11,302 ft.

of reinforced concrete and inner lanes of bituminous macadam and having a 3-ft. painted center separation strip for opposing lines of traffic. A raised, sloped-face dividing island averaging 6 to 8 ft. in width is also being used when sufficient highway width is available to permit its inclusion with the traffic lanes. This method at present appears to be recognized as the most effectual for traffic separation. Greater attention is being given to the development of landscaping of roadsides. The incorporation in the construction contracts of items covering the grading, loaming and planting of slope areas makes it possible to combine operations so that when completed the roadsides present an appearance in conformity with the new highway. Mileages and expenditures are given as follows:

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	10.56
Bituminous types (including surface treated stabilized bases)	6.27
Graded and drained (including gravel or other untreated mineral surfaces)	
Total mileage constructed in 1939	16.83

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$1,423,030.13	$1,750,000
Maintenance	904,384.55	1,200,000
Equipment	26,568.70	50,000
Total	2,353,983.38	3,000,000

Connecticut pushes arterials

Wm. J. Cox, state highway commissioner, states that during 1939 unusual emphasis has been placed upon the development of main arterial highways. The major portion of the Merritt Parkway has been completed. This is a four-lane express highway leading from the New York State line 38 miles east toward New Haven. Connecticut's 1939 General Assembly made financial provisions for extending this parkway from the Housatonic River east and north through New Haven and Hartford to connect on the northeastern boundary with Massachusetts' main traffic artery eastward into Boston. Commissions were appointed to consider and, if practicable, build new bridges for arterial traffic across the Connecticut River at Hartford and the Thames River at New London. The state highway department has just initiated a comprehensive survey of all matters of policy, methods, procedure and organization involved in its prescribed functions. The federal Public Roads Administration is cooperating in this survey. The construction figures and planned expenditures are as follows:

MILEAGE, Fiscal Year	1938–1939
Hard surface (concrete, brick, block)	36.28
Bituminous types (including surface treated stabilized bases)	15.62
Graded and drained (including gravel or other untreated mineral surfaces)	5.35
Total mileage constructed in 1938–39 Fiscal Year	57.25

EXPENDITURES, Calendar year	Estimated 1939	Estimated 1940
Construction	$10,100,000	$9,863,320
Maintenance	2,900,000	3,660,715
Equipment	250,000	412,261
Total	13,250,000	13,936,296

Maine tries special concrete

L. D. Barrows, chief engineer, reports as follows: We have constructed an experimental section of concrete using on one section an admixture of natural cement and on another Vinsol resin cement. This was done to determine if such admixtures would be helpful in resisting concrete scaling. During 1939 we have tried several gravel road projects mixing the surface gravel in place with the bituminous material to provide about a 2-in. surface. So far, we have been much pleased with the results obtained. On some of the projects this method has been used to provide a final surface, and on others to provide a temporary surface on stage construction projects. As far as we know at this time the work for 1940 will probably be along the same lines as in 1939. We have two or three fairly large bridge projects which it will probably be necessary to undertake within the next two seasons. Mileages and expenditures are as follows:

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	6
Bituminous types (including surface treated stabilized bases)	287
Graded and drained (including gravel or other untreated mineral surfaces)	37
Total mileage constructed in 1939	330

EXPENDITURES	Estimated 1939	Estimated 1940
Construction	$5,905,000	*$6,200,000
Maintenance (including snow removal)	3,850,000	3,580,000
Equipment (construction and maintenance)	66,184	90,000
Total	9,821,184	9,870,000

* Includes: Highways, $4,100,000; bridges, $1,490,000; grade crossings, $315,000.

Vermont builds to fit traffic

Reporting work done in 1939 and expenditures contemplated in 1940, H. E. Sargent, commissioner of highways, says: The policy of the highway board is to provide the maximum mileage of all-weather roads possible with the money available. The department has been able to proceed on this basis by developing comparatively low-cost but practical surfaces, which are adequate to our traffic conditions and allow us to build the maximum mileage of automobile roads on first class subgrade construction.

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	2.9
Bituminous types (including surface treated stabilized bases)	50.9
Graded and drained (including gravel or other untreated mineral surfaces)	.....
Total superior-to-gravel mileage constructed in 1939	53.8

EXPENDITURES	Estimated 1939	Estimated 1940
Construction	$4,000,000	$4,000,000
Maintenance	1,750,000	750,000
Equipment	250,000	250,000
Total	6,000,000	6,000,000

Massachusetts expects less work

Construction dropped off in 1939. It is anticipated that no new funds will be made available for major construction in 1940. Such balances as are available will be used largely for continuation of work on new routes now under construction or in correcting dangerous conditions on the existing routes.

MILEAGE	Built in 1939
Hard surface concrete	3
Bituminous types	50
Graded and drained	6
Total mileage constructed in 1939	59

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$2,384,416	$1,294,404
Maintenance	5,185,253	5,080,778
Equipment	231,661	228,000
Total	.....	.....

Middle Atlantic States

New York expects more funds

Road improvements in 1939 were the smallest in many years because of reduced appropriations by the state legislature. Transfer during the year of grade crossing elimination work, with state bond issue money, to the division of highways built up the highway expenditures somewhat but not nearly to normal figures. An increase is expected in 1940. With $6,000,000 in grade crossing money and the prospect that the 1940 legislature will restore the budget cuts of 1939, a doubling of the 1939 expenditures is anticipated. Among the noteworthy construction operations for the present year are the completion of the four-lane divided highway by-pass that will replace the famous and hazardous Storm King highway and the construction of 9 miles of four-lane divided highway known as the Middletown by-pass and estimated to cost $3,000,000. The figures for 1939 and 1940 based on information from state highway officials but unofficial, are as follows:

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	210
Bituminous types (including surface treated stabilized bases)	40
Graded and drained (including gravel or other untreated mineral surfaces)	16
Total mileage constructed in 1939	266*

* Figures are estimated, no official figures available.

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$19,500,000	$37,550,000
Maintenance	8,900,000	9,500,000
Equipment	900,000	1,000,000
Total	29,300,000	48,050,000

Pennsylvania plans are normal

Roadbuilding has reached the point where it runs evenly from year to year, reports T. C. Frame, state highway engineer. The figures for 1939 and 1940, calculated from fiscal year records, are as follows:

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	150
Bituminous types (including surface treated stabilized bases)	300
Graded and drained (including gravel or other untreated mineral surfaces)	100
Total mileage constructed in 1939	550

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$25,000,000	$25,000,000
Maintenance	30,000,000	30,000,000
Equipment	500,000	500,000
Total	55,500,000	55,500,000

Maryland steps up quality

With one of the oldest completely surfaced state road systems, Maryland, says Wilson T. Ballard, state highway engineer, is widening traffic lanes from 10 ft. to 12 ft. on main roads and developing roadside borders by streamlining profiles and landscaping. In 1940 it is planned to use for the first time in Maryland high-visibility mural strips in the separation of opposing lines of traffic, at approaches to bridges and on divided highways on which wide parked median strips are impracticable. More attention will be given to erosion control in deep cuts by terracing, perforated-pipe underdrainage and other construction methods. The construction figures for 1939 and as estimated for 1940 are as follows:

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	41.76
Bituminous types (including surface treated stabilized bases)	44.67
Graded and drained (including gravel or other untreated mineral surfaces)	43.38
Total	129.81

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$7,247,315	$7,087,394
Toll bridges	1,644,281	8,118,170
Maintenance	2,834,692	3,116,108
Equipment	263,324	363,500
Other	$7,488,562	2,522,703
Total	19,478,244	21,207,875

New Jersey studies curb designs

Improved design and increased use of reflecting curb and median strip paving is reported by James Logan, state highway engineer. Based on tests and field trial a curb has been designed with an inclined face having ribs that form panels which reflect the light from automobile headlights. Surfaced with white cement the curbs are sharply visible at night. On narrow median strips with paved tops the concrete slabs are of dark cement and corrugated to reduce glare. This construction gives excellent visibility without glare in both rain and fog. A view of one of the New Jersey reflecting curb installations is shown on the next page. The roadwork for 1939 and the estimated expenditures for 1940 are as follows:

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	18*
Bituminous types (including surface treated stabilized bases)	0
Graded and drained (including gravel or other untreated mineral surfaces)	18†
Total mileage and widening constructed in 1939.	57

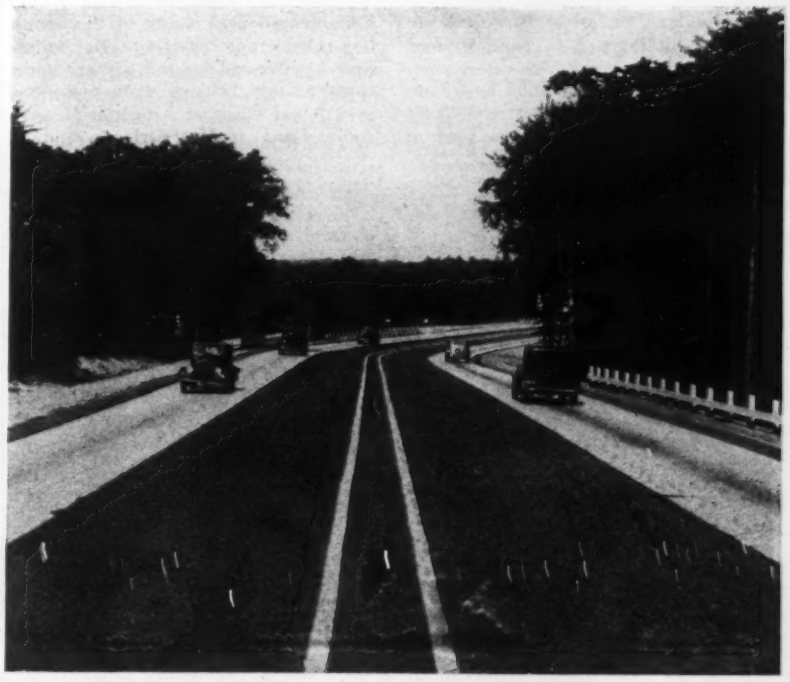
* Plus 6 mi. widening. † Plus 15 mi. widening.

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$13,284,817	No figures
Maintenance	3,400,000	$3,400,000
Equipment	280,000	200,000
Total	16,964,817	.....

Delaware lights intersections

This past year we have gone ahead with our program of lighting important intersections, reports W. W. Mack, state highway engineer. Two separate lighting contracts were let and two others are included in the construction of an overhead crossing and a viaduct. The building of our system of divided highways continued. About 105 miles of traffic-bound roads were raised to secondary classification by means of bituminous surface treatments.

Aside from the paving of the divided highways mentioned above, the major work in 1940 will be reconstruction and widening; many of our divided highways utilize as one lane the original



Dual type pavement, characteristic of state practice, is represented in its highest development in this Rhode Island highway.

highway built from 1919–1923, and about 15 miles of these roads will be reconstructed and resurfaced. At least two large overhead crossing elimination projects will be built during 1940. The latest development in Delaware highway construction is subgrade stabilization under pavements. The work of 1939 and that contemplated for 1940 is reported as follows:

MILEAGE	Built in 1939
Hard surface (concrete)	24.6*
Bituminous types (including surface treated stabilized bases)	105.0
Graded and drained (including gravel or other untreated mineral surfaces)	28.6
Total mileage constructed in 1939	267.9

* 37.0 mi. of 4-ft. widening; 7.4 mi. of 20-ft. roadway.

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$1,591,761	$1,250,000
Maintenance	949,157	900,000
Equipment	94,000	90,000
Total	2,634,918	2,240,000

Southern States

North Carolina widens surfaces

W. Vance Baise, state highway engineer announces that the state has continued and will continue widening and grade and line revision on its main roads. The figures for 1939 and 1940 follow:

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	204*
Bituminous types (including surface treated stabilized bases)	818*
Graded and drained (including gravel or other untreated mineral surfaces	990
Total mileage constructed in 1939	2,012

* Includes widening.

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$15,430,000	$13,500,000
Maintenance	12,300,000	12,500,000
Equipment	724,820	720,000
Total	28,454,820	26,720,000

South Carolina work active

J. W. Williamson, state highway engineer, reports promising activity despite threatened reduction of funds. Legislation threatening diversion of gasoline tax funds in 1939 jeopardized the certainty of funds which would be available for contracts. However, the legislature adjourned in June without seriously affecting the highway department's funds and since June new state highway contracts, aggregating $3,000,000, have been let. A large part of the work on these contracts will be carried over into 1940 and it is expected that additional work will be put under contract just as fast as funds become available. According to the present outlook, the highway department will be able to finance new highway contracts aggregating between six and seven millions of dollars in 1940. This work will include about 300 miles of new bituminous surface roads, concrete and bituminous widening work, bridges, and about 10 miles of concrete pavement on dual lane roads, grade separation projects, etc. The partial figures available are as follows:

Total mileage constructed in 1939	300

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$8,000,000	$6,500,000
Maintenance	2,583,093	.....
Equipment	380,027	.....
Total	10,963,120	.....

Louisiana continues heavy work

An official statement from the state highway commission announces that besides the mileages shown by the tabulation five grade crossing eliminations have been completed and six are under construction; bridges were completed over Boeuf River at Alto, the Metairie Relief Canal in New Orleans, and the Tangipahoa River near Ponchatoula. Construction is now in progress on bridges over Caddo Lake near Mooringsport, Cross Bayou and Twelve-Mile Bayou near Shreveport, the New Basin Canal in New Orleans, Bayou Teche at New Iberia and Bayou Lafourche at Lockport. Three of the four contracts for the Mississippi River bridge at Baton Rouge have been completed. The cost of all contracts for the bridge and its approaches is $10,156,000.

On the new outlet from New Orleans, over the Airline Highway, 4.4 miles of divided lane pavement were completed during the year and the remaining 2.5 miles are to be completed in the near future. Another divided lane approach to New Orleans is also under construction between Arabi and Chalmette. At Shreveport a new divided lane outlet to the northwest is now under construction.

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	51
Bituminous types (including surface treated stabilized bases)	33
Graded and drained (including gravel or other untreated mineral surfaces)	258
Total mileage constructed in 1939	342

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$11,574,000	$14,986,780
Maintenance	2,338,111	3,500,000
Equipment	.....	100,000
Total	13,912,111	18,586,780

Mississippi continues program

Referring to the large program started a few years ago, R. A. Harris, chief engineer, reports that out of a total of 6,500 miles under state jurisdiction 3,200 miles of pavement have been completed or are under construction. In 1940 there will follow completion of the priority system and major secondary highways of the state and the continuation of the elimination of grade crossings. The mileages and expenditures are:

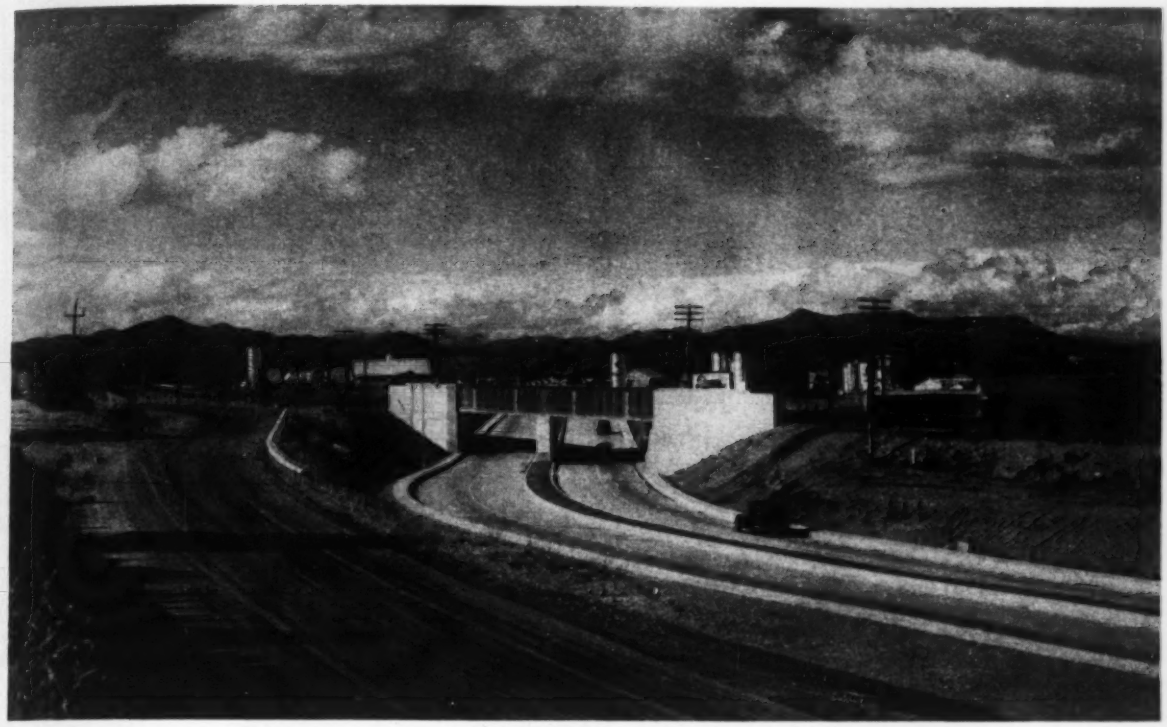
MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	287.7
Bituminous types (including surface treated stabilized bases)	166.8
Graded and drained (including gravel or other untreated mineral surfaces)	261.8
Total mileage constructed in 1939	716.3

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$23,429,000	$12,000,000
Maintenance	1,708,000	1,500,000
Equipment	125,000	150,000
Total	25,272,000	13,650,000

Alabama increases operations

Chris. J. Sherlock, highway director, reports a pronounced upward trend in construction. During the fiscal year ending Oct. 1, 1939, $11,303,000 was expended for construction which amounted to more than has been spent since 1929 during which year the greater part of Alabama's second $25,000,000 bond issue was expended. It is estimated that there will be a slight de-

The definite trend toward high-visibility curb is exemplified in this reflecting curb of white cement being used on a paved median strip in New Jersey.



Outstanding is grade crossing elimination, often obtained by costly relocation, as exemplified by this California operation where the Pacific Highway enters the city of Redding.

crease of mileage in the various types of road construction for the year ending Oct. 1, 1940, caused by a higher standard of construction being effected during 1940. Alabama's forecast for the year ending Oct. 1, 1940, and achievements for the year 1939 follows:

MILEAGE, 1939	
Graded and drained	693
Temporary surface	100
Base course	588
Bituminous prime only	617
Bituminous mat only	624
Bituminous seal coat	688
Bridges	5
Other pavement	3
Total	3,318

EXPENDITURES	1939	1940
Construction	$11,303,910	$11,300,000
Maintenance	2,076,286	2,000,000
Bond Retirement	...	...
Interest, All Other	6,710,133	5,500,000
	$20,170,329	$18,800,000

Tennessee

Partial records from the state highway department give the following figures:

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	84
Bituminous types (including surface treated stabilized bases)	12
Graded and drained (including gravel or other untreated mineral surfaces)	108½
Total mileage constructed in 1939	204½

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$7,300,000	$9,800,000
Maintenance	3,400,000	3,400,000
Total	$10,700,000	$13,200,000

Virginia widens lanes

With an elaborate statistical statement that in part follows C. S. Mullen, state highway engineer, reports on special work for 1940 as follows: Several millions of dollars have been appropriated to continue the widening to multiple-lane roadways of those 2-lane roads now subject to traffic congestion. The plant-mix surfacing is most outstanding, and the volume will be about the same as used in previous years, about $900,000 worth. Ordinary surface treatment work will be continued with a proposed expenditure of about $2,000,000. Sidewalk construction will also be continued in 1940. A program of 55,304 lin. ft. has been laid out for the fiscal year ending June 30, 1940, of which 21,000 ft. has been completed.

The estimated expenditures for the year 1939 are as follows:

Primary State Highway System	
Approximately 461 mi. of primary roads graded, surfaced and widened at a cost of about	$12,600,000
146 mi. yet to be graded and surfaced, carried over into the next calendar year at an estimated cost of	2,300,000
Ordinary maintenance	2,300,000
Resurfacing, replacement and improvements, approx	2,700,000
240 mi. of maintenance placed by contract at a cost of	846,000
Secondary Highway System	
Ordinary maintenance	2,700,000
Construction, resurfacing and improvement	4,320,000

PRIMARY STATE HIGHWAY CONSTRUCTION 1939 AND 1940

Type of Road	Mileage completed during calendar year 1939	Incompleted mileage carried over to year 1940	Probable new construction during 1940
Graded and drained	11.017	0.000	5.00
Gravel, soil, untreated	27.160	14.220	...
Gravel, soil, treated	82.741	19.057	100.000
Macadam, untreated	42.988	14.570	...
Macadam, bituminous surfaced	202.718	56.742	240.00
P. C. Concrete	10.236	17.411	10.00
Sheet Asphalt and bituminous Concrete	0.470	0.000	10.00
Bridges and Separation Structures (No.)	70	17	80
Sub-total, exclusive of widening	377.330	122.000	365.
Widening			
Macadam, bituminous surfaced	4.719	14.180	15.00
P. C. Concrete	43.637	4.531	75.00
Sheet Asphalt and bituminous Concrete	35.581	6.150	40.00
Bridges	9	2	20
Total, including widening	461.79	147.19	485.100

Note: In addition to new construction itemized under primary system, there was surfaced with bituminous concrete, out of funds allocated to improvement, resurfacing and replacement, supervised by the maintenance department, a total of 240 miles at a cost of $846,000. It is expected that at least an equal mileage will be surfaced in this manner during 1940.

West Virginia

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	36.9
Bituminous types (including surface treated stabilized bases)	1,202.9
Graded and drained (including gravel or other untreated mineral surfaces)	236.7
Total mileage constructed in 1939	1,475.6

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$10,100,000	$10,000,000
Maintenance	5,925,000	5,800,000
Total	16,025,000	15,800,000

Kentucky maintains activity

Reporting no particular policy or trend, state highway engineer T. C. Cutler, gives the following figures for 1939 and 1940:

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	74
Bituminous types (including surface treated stabilized bases)	79
Graded and drained (including gravel or other untreated mineral surfaces)	275
Total mileage constructed in 1939	428

EXPENDITURES	Actual 1939*	Estimated 1940
Construction	$7,271,157	$9,000,000
Maintenance	3,552,502	5,000,000
Equipment	311,862	500,000
Total	11,135,521	14,500,000

* From 1-1-39 to 11-30-39.

Florida continues wide roadways

J. H. Dowling, state highway engineer, defines the characteristic trend of highway construction as being toward the 2-lane roadway, using two 11-ft. lanes with a separating strip varying from 4 to 6 ft. in width. This separating lane is a regular section of the roadway but is painted black to mark the separation. Another trend has been toward having gentle front slopes, shallow ditches and gentle back slopes—this being accomplished by acquiring 200-ft. right-of-way and changing front slopes from 1 on 2 and 1 on 4 to 1 on 6 or even flatter. No budget figures are available for 1940; 1939 figures are as follows:

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	15.68
Bituminous types (including surface treated stabilized bases)	251.06
Graded and drained (including gravel or other untreated mineral surfaces)	141.74
Total mileage constructed in 1939	408.48

EXPENDITURES*	Actual, 1939
Construction	$13,182,982.04
Maintenance	3,444,210.19
Equipment	.....
Total	16,627,192.23

* No data available for 1940.

Georgia suffers from diversion

The outstanding feature of the road work of the Georgia State Highway Department during 1939 was the development of rural roads. Road construction was greatly curtailed, however, because of the diversion of road funds to pay the salaries of school teachers. Because of this diversion, federal funds could not be obtained and for the last few months of the year, little roadbuilding was done. The 4-lane concrete Marietta Highway, which was supposed to be finished in 1939, will be completed in 1940. All funds of the State Highway Department are expected to be used for road purposes in 1940 and matched with federal funds; extended road work is contemplated, which will continue the 1939 program of developing farm-to-market roads. Statistics for 1939 and 1940 follow:

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	49
Bituminous types (including surface treated stabilized bases)	370
Graded and drained (including gravel or other untreated mineral surfaces)	593
Total mileage constructed in 1939	1,010

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$12,406,000	$13,000,000
Maintenance	3,500,000	3,000,000
Equipment	1,003,000	500,000
Total	16,909,000	16,500,000

Middle Western States

Illinois faces replacement

Ernst Lieberman, state highway engineer, considers the pressing task to be modernization and replacement of existing pavements. Illinois has many miles of high-type pavement some of which dates back twenty years or more and was not designed for the speeds and truck loadings of today nor with modern safety features. Obsolescence and wear and tear have made these roads inadequate and now replacement is the first consideration. The program for 1939 has centered on replacement and it must continue to stress this work for several years until these older roads will meet present-day safety requirements, intensity and speed of traffic and increased truck loadings. With this revamping, an extensive program of road and railroad grade separation was carried on in 1939 and will be continued in 1940. The work done in 1939 and that planned for 1940 is as follows:

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	177.21
Bituminous types (including surface treated stabilized bases)	211.30
Graded and drained (including gravel or other untreated mineral surfaces)	179.99
Total mileage constructed in 1939	568.50

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$20,000,000	$31,306,000
Maintenance	5,530,000	6,950,000
Equipment	455,000	950,000
Total	25,985,000	39,206,000

Indiana revamps and refines

M. A. Newlin, office engineer, reports in 1939 special activity in divided lane highways, roadside parks, installation of railroad flashing signals, and sodding shoulders and backslopes. Elimination of passing zones, and the salvaging of worn-out surfaces with natural rock asphalt, have been the most characteristic trends in 1939. Indiana has used all of its secondary federal-aid allocations. In 1940 the highway department expects an expansion of safety work in the form of educational work, publicity and design. The decreased personnel resulting from budget reductions by 1939 General Assembly is delaying preparation of 1940 construction work. The figures from 1939 work are:

MILEAGE	Year ending 6-30-39
Hard surface (concrete, brick, block)	103.699
Bituminous types (including surface treated stabilized bases)	137.171
Graded and drained (including gravel or other untreated mineral surfaces)	38.344
Rock asphalt resurfacing	239.210
*Total mileage constructed in 1939	518.324

* This does not include 83 mi. of surface treatment and 746 mi. of road oil application which was completed in 1939 calendar year.

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$12,609,544.13	$19,533,000
Maintenance	4,503,603.72	4,500,000
Equipment	295,732.91	.....
Sub-total	17,408,880.76	.....
Misc. and supervisory service and special maintenance	4,714,601.47	3,082,000
Total state funds	22,123,482.23	.....
Federal aid	3,371,509.00	.....
Total	$25,494,991.23	$27,115,000

Ohio advances technique

H. G. Sours, chief engineer, reports as follows: Since 1935 the department has had a specification for compacting earth embankments, based on the fundamental principles of the Proctor test. Refinement in control prompted a more comprehensive specification which was developed and adopted in 1939. The results have exceeded the expectations so that in over 10,000 compaction tests made on 103 projects in 1939 showed an average compaction of more than 100 per cent and only 11 less than 95 per cent. The embankment specification now requires scarifying through all cuts and recompaction of subgrade material. This results in uniform compaction throughout the projects, covering both cut and fill. The results have been very satisfactory.

On hard surface pavements, this year, nothing less than 11-ft. lanes have been built and, in some cases, where heavy bus and truck traffic is encountered, the width used was 12 ft. Secondary roads are ordinarily being improved with 10-ft. lanes.

In 1940 an experimental job will be built from Columbus west, in which concrete made with cements with vinsol

A sound policy of holding fast to stabilized foundations and ample cross-profile dimensions when light traffic and small funds keep surfacing investment small, is represented by this Vermont road.

resin and beef tallow as grinding aids will be used, as well as concrete made with ordinary portland cement. The project also includes concrete made with different blends of ordinary portland cement and natural cements. In all, the entire project is 8 miles long, 2 lanes wide, and includes 23 experimental sections, each of which will be duplicated.

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	Est. 353
Bituminous types (including surface treated stabilized bases)	1,396
Graded and drained (including gravel or other untreated mineral surfaces)	31
Total mileage constructed in 1939	1,780

EXPENDITURES	Est. 1939	Est. 1940
Construction	$22,000,000	$23,000,000
Maintenance	12,500,000	13,000,000
Equipment	605,000	625,000
Total	35,105,000	36,625,000

Michigan expects more work

Reporting the mileages and expenditures given below, H. C. Coons, chief engineer, states that concrete road construction work was delayed somewhat pending adjustment of state revenues, and consequently this type of surfacing did not reach 1938 totals. In general, 1939 recorded a high percentage of low-cost surfacing. The outlook for 1940 construction includes the usual matching of regular and secondary federal-aid funds, and the expenditure of current grade-crossing funds. Improved economic conditions are expected to produce an increase in gasoline and tax receipts and it is hoped the federal-aid program may be augmented by some 100 per cent state construction work. Estimates, at this time, place the 1940 construction account about 10 per cent above 1939. Present plans indicate an acceleration in concrete road construction and bridge projects, with a continuation of low cost surfacing at about the 1939 level.

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	63
Bituminous types (including surface treated stabilized bases)	240
Graded and drained (including gravel or other untreated mineral surfaces)	122
Total mileage constructed in 1939	425

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$13,500,000	$15,000,000
Maintenance and traffic service	7,000,000	7,000,000

Wisconsin increases bypasses

E. L. Roettiger, state highway engineer, reports no markedly unusual trend in the state's 1939 highway program. Volume of pavement constructed in 1939 was higher than several previous years. Most noteworthy is the increasing number of bypasses and belt lines initiated and under way around congested areas, many of them having strong local support of the cities affected thereby.

MILEAGE	Built in 1939
Hard surface (concrete, brick block)	142
Bituminous types (including surface treated stabilized bases)	159
Graded and drained (including gravel or other untreated mineral surfaces)	102
Total mileage constructed in 1939	439

EXPENDITURES	Actual 1939	Estimated 1940*
Construction	$8,500,000	*
Maintenance	5,500,000	†
Equipment	None	None
Total	14,000,000	

* Due to the fact that the highway funds that may be available for state highway work in 1940 cannot be estimated with any reasonable degree of certainty the State Highway Commission is reluctant to issue any statement as to the possible 1940 program.

† Maintenance budget not yet set up. Best available estimate is that it will approximate 1939.

States West of Mississippi

Oklahoma steps up construction

In Oklahoma the payment of an inherited debt of $5,000,000 from current revenues of the department practically stopped all construction work during the first half of 1939. Since July, the department has built 7.157 mi. of 4-lane highway in Oklahoma county, the first of that type within the state. Grade crossing elimination has continued and several existing underpasses have been enlarged. The Bixby Bridge across the Arkansas River was the largest bridge built during the year. State aid construction work was held to a small amount on account of finances. In 1940 the construction of additional four-lane highways near Tulsa and Oklahoma City will be continued. It is expected to make a start on the short-cut highway between the two cities during the year. Stabilizing of earth shoulders on existing highways will be continued. About $6,000,000 will be spent in matching federal aid construction, $3,500,000 for maintenance, and an additional $2,000,000 for grade crossing elimination.

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	39.7
Bituminous types (including surface treated stabilized bases)	189.9
Graded and drained (including gravel or other untreated mineral surfaces)	191.5
Total mileage constructed in 1939	421.1

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$10,400,000	$12,000,000
Maintenance	3,000,000	3,500,000
Equipment	1,300,000	1,000,000
Total	14,700,000	16,500,000

Where industrial centers are close and population is dense the multiple-lane highway, like this Massachusetts road, is calling for increasing consideration.

Minnesota reports work done

O. M. Kipp, construction engineer, gives the following figures of work completed during 1939 and planned for the current year.

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	17.5
Bituminous types (including surface treated stabilized bases)	241.7
Graded and drained (including gravel or other untreated mineral surfaces)	280.3
Total	539.5

EXPENDITURES (Jan. 1 — Dec. 31, 1939) (Months of Nov.-Dec. are estimated)	Actual 1939	Estimated 1940
Construction	$7,805,220	$11,300,858
Maintenance	6,477,235	8,208,480
Total	14,282,455	19,509,338

Missouri statistics

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	69.1
Bituminous types (including surface treated stabilized bases)	128.8
Graded and drained (including gravel or other untreated mineral surfaces)	303.6
Total mileage constructed in 1939	501.5

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$7,550,000	$10,800,000
Maintenance	6,200,000	6,200,000
Total	13,750,000	17,000,000

Iowa adds to secondary mileage

The trend in this state is apparently for greater emphasis on secondary roads, states C. Coykendal, engineer of estimates and contracts. Owing to the fact that $1,250,000 of primary road fund was set aside, by legislative act, to match federal secondary funds, 1939 has witnessed a decrease in primary road construction, and a corresponding increase in secondary road work.

It is difficult to foresee at this time any new developments in the 1940 highway program. Continuing emphasis on the development of a usable system of secondary or farm-to-market roads is probable. We are doing more work and better work in subgrade investigation and treatment each year, and the federal secondary-road program now under way will have a tendency to extend such investigations to secondary roads. Funds available for highway construction work, both on the primary system and on secondary roads are quite inadequate to meet the demands of road users for road improvements. Mileages and expenditures are as follows:

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	142.5
Bituminous types (including surface treated stabilized bases)	107.0
Graded and drained (including gravel or other untreated mineral surfaces)	327.0
Total mileage constructed in 1939	576.5

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$10,283,000	$11,300,000
Maintenance	3,689,000	3,800,000
Equipment	136,000	200,000
Total	14,108,000	15,300,000

Texas cuts maintenance costs

As reported by E. J. Amoy, administrative assistant, the average cost per mile of maintenance of all state highways has steadily decreased with the completion of higher type roads as reflected below:

Year Ending August 31	Average Per Mile
1930	$413.89
1931	355.13
1932	340.32
1933	302.90
1934	295.34
1935	360.35
1936	354.18
1937	321.29
1938	314.14
1939	289.92

The increase of 1935 was caused by increased cost of labor and materials over the low level of depression years preceding. Ordinary maintenance of past years has been increased by many traffic service operations, such as centerline marking; erection and maintenance of signs and markers; reflectorizing signs and guard posts outlining curves.

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	190.1
Bituminous types (including surface treated stabilized bases)	1,152.0
Graded and drained (including gravel or other untreated mineral surfaces)	1,939.2
Total mileage constructed in 1939	3,281.3

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$34,172,326	$34,172,326
Maintenance	12,084,437	12,084,437
Equipment	632,614	632,614
Total	46,889,377	46,889,377

Nebraska seeks low-cost types

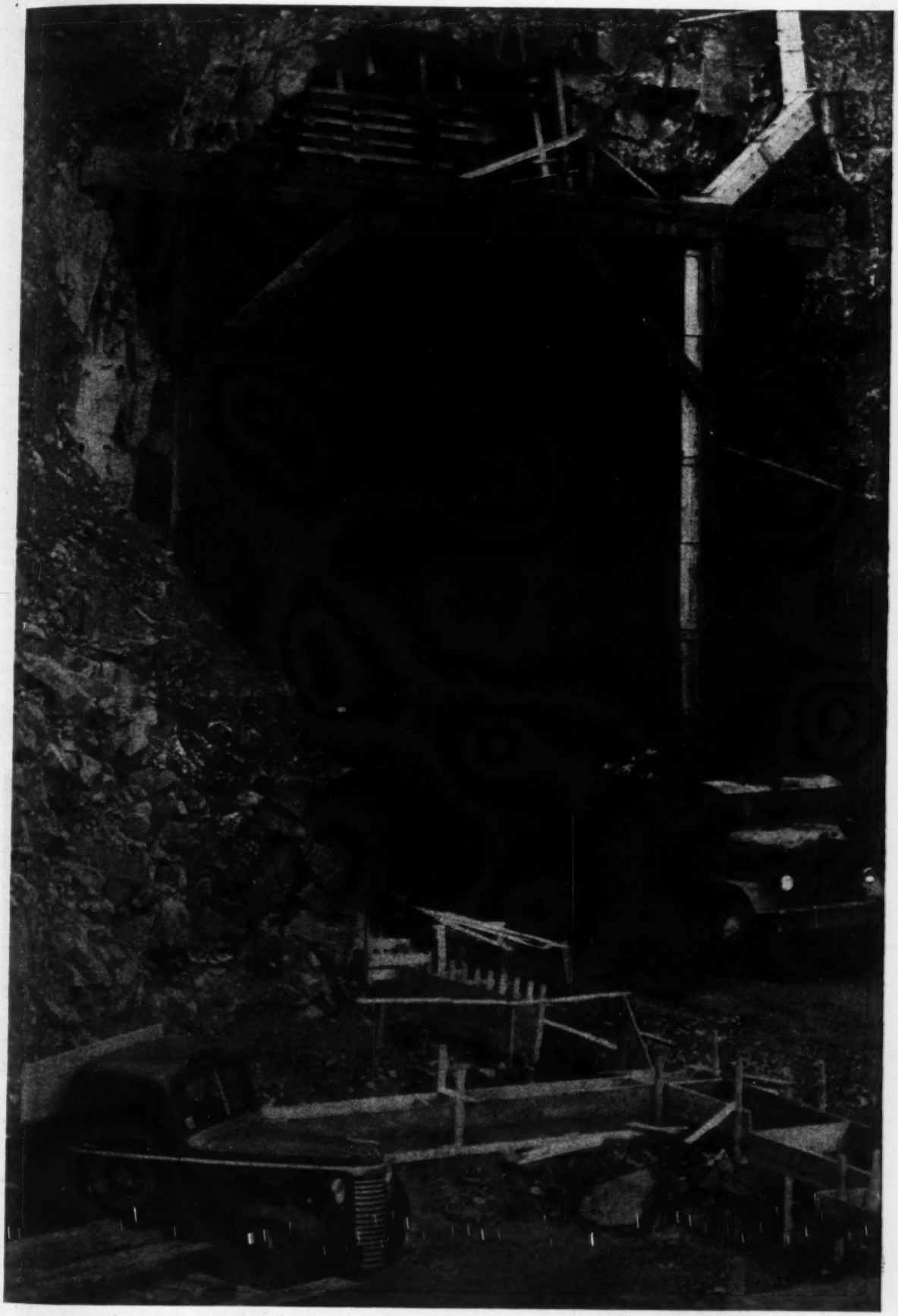
A. C. Tilley, state engineer, reports that roadwork in Nebraska is on a "pay-as-you-go" basis. Nebraska has a large area, a large highway mileage and relatively small construction funds each biennium. Traffic ranges from a high of approximately 4,000 to a low of less than 100. As a consequence, the development of low-cost stabilized-base courses and low-cost pavements has been natural, and it has been necessary to put great emphasis on this phase of construction in order to develop a low-cost type, or several types, suitable to the soils, climatic and traffic conditions that permit completion of surfacing in a reasonable time with funds available.

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	23
Bituminous types (including surface treated stabilized bases)	302
Graded and drained (including gravel or other untreated mineral surfaces)	808
Total mileage constructed in 1939	1,133

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$6,900,000	$6,900,000
Maintenance and Equipment	3,000,000	3,000,000
Total	9,900,000	9,900,000

Arkansas Takes Safety Measures

W. W. Mitchell, director of highways, believes that the outstanding performance of the department for the 1939 calendar year can be considered as the developing of intensive safety measures upon the major highways of the state. These measures included speed zoning and marking, reflectorizing signs and guard posts, and stabilizing shoulders. The results secured are considered beneficial and popular



Biggest road job of the year was the Pennsylvania Turnpike which includes seven tunnels totaling 6.7 miles long.

as it is anticipated that further refinements of like nature will be emphasized during 1940. Mileages and expenditures are as follows:

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	18
Bituminous types (including surface treated stabilized bases)	85
Graded and drained (including gravel or other untreated mineral surfaces)	64
Total mileage constructed in 1939	167

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$3,406,275	$3,500,000
Maintenance	3,120,000	3,120,000
Equipment	225,000	225,000
Total	6,751,275	6,845,000

Kansas sets higher standards

R. B. Wills, state highway engineer, states that the general trend of the 1939 program has been to provide more adequate surfaces on those sections of highway which have previously been brought to standard grade and proper drainage; also, the completion of gaps existing on the main traffic arteries. The compaction of embankments and stabilization of roadbeds have received considerable attention. Plans for 1940 are not yet complete, but it is not likely that any unusual features will be involved. Construction for 1939 and that planned for 1940 is:

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	23.6
Bituminous types (including surface treated stabilized bases)	184.4
Graded and drained (including gravel or other untreated mineral surfaces)	368.4
Total mileage constructed to Nov. 30, 1939	576.3

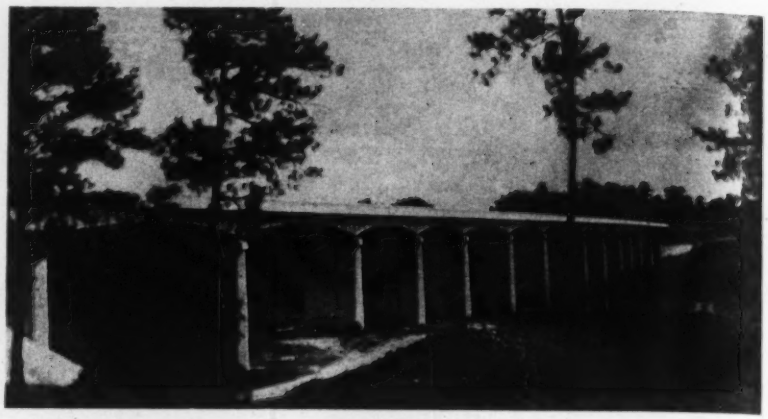
EXPENDITURES	Actual to 11/30/39; December estimated	Estimated 1940
Construction	$6,850,000	$8,600,000
Maintenance	2,750,000	3,540,000
Equipment	913,000	960,000
Total	10,513,000	13,100,000

South Dakota improves subgrade

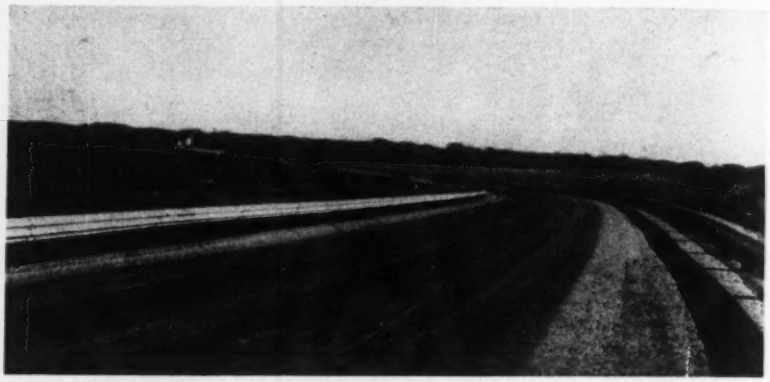
E. W. Meeker, state highway engineer, reports a definite trend toward streamlining the cross-profile of roads to reduce snow trouble. In 1939 stress also was laid on grade solidification by means of sheepsfoot rollers and water compaction, and machine tamping around structures. These developments will be extended in 1940 and further study will be given to cross-profile to reduce the accumulation of snow. The roadwork for 1939 and the estimated expenditures for 1940 are as follows:

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	25.614
Bituminous types (including surface treated stabilized bases)	283.148
Graded and drained (including gravel or other untreated mineral surfaces)	167.009
Total mileage constructed in 1939	475.771

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$4,000,000	$4,000,000
Maintenance	2,100,000	2,200,000
Equipment	145,000	75,000
Total	6,245,000	6,275,000



The long viaduct across wide bottomlands subject to overflow, like this 1,504-ft. Georgia bridge over the Savannah River, is a characteristic problem of Gulf and South Atlantic state roadbuilding.



Bituminous armor coat on a 6 to 8-in. base of stabilized natural soil is a characteristic prairie and plains state construction represented by this road in Kansas.

New construction in Wisconsin is characterized by ample shoulders, seeded to check erosion, and paved drains over the shoulder.

North Dakota lacks funds

Reporting failure of state to provide sufficient funds to match federal aid and carry on an adequate construction program, Z. E. Sevison, state highway engineer, gives the following figures of work accomplished during 1939 and planned for the current year.

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	...
Bituminous types (including surface treated stabilized bases)	295
Graded and drained (including gravel or other untreated mineral surfaces)	...
Total mileage constructed in 1939	295

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$3,080,191	$2,770,000
Maintenance	1,356,711	1,516,000
Equipment	27,000	70,000
Total	4,463,902	4,356,000

Far West States

Wyoming stresses soil surveys

A report from Frank Kelso, superintendent, tells of new soil studies. In general, to eliminate the dust problem on the mountain highways—which are on direct routes to and through the scenic attractions of the state—Wyoming has found it necessary to rapidly increase its oil mileage. Several hundred miles of low type surface treatment have been constructed in the mountain roads during the past construction season. Along with the activity described above, Wyoming's second major work has been to improve the heavy traveled through highways to a high standard of both geometric and structural design. No new developments are expected in the work for the next year except to continue to improve the technique of design and construction as it has been carried on in the past. The department is using a special prospecting machine which closely follows in design the one worked out by O. J. Porter of the California highway department. Not only are bridge foundations being more carefully explored, but complete tests are being provided for contractors bidding on the work so that they can see more closely the type of material which will develop on construction. In addition, soil samples along the line are tested in the laboratory and maximum densities to be obtained on construction are determined; 90 to 100 per cent of the maximum density with the optimum moisture contained is being obtained on construction and it is expected to improve the technique during the coming year. The mileages and expenditures for 1939 and the estimated expenditures for 1940 are as follows:

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	.....
Bituminous types (including surface treated stabilized bases)	400
Graded and drained (including gravel or other untreated mineral surfaces)	130
Total mileage constructed in 1939	530

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$3,700,000	$3,700,000
Maintenance	750,750	750,000
Equipment*	.....	.....

*No direct expenditures—included in maintenance costs.

New Mexico has planned program

In a recent statement on policy Governor Miles says:

"In a state as large as New Mexico, with such relatively small population it is difficult to fill all highway needs as promptly as we wish. However, we are closing up unpaved gaps just as rapidly as our limited funds will permit, and we are planning our construction program in such a way that the roads which we build in the future will serve the dual purpose of providing farm-to-market outlets for our own residents and at the same time take care of our heavy tourist flow.

"I believe this policy to be an ideal one for New Mexico. Our tourist business is our largest cash industry and the more tourists we can encourage to visit our state, the more income we will have from gasoline tax collections and consequently the more highways we can build for the use of New Mexico residents."

The following figures are from the highway department records:

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	...
Bituminous types (including surface treated stabilized bases)	269
Graded and drained (including gravel or other untreated mineral surfaces)	297
Total mileage constructed in 1939	566

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$5,086,000	$5,000,000
Maintenance	1,463,000	1,500,000
Equipment	450,000	350,000
Total	6,999,000	6,850,000

Montana improves practices

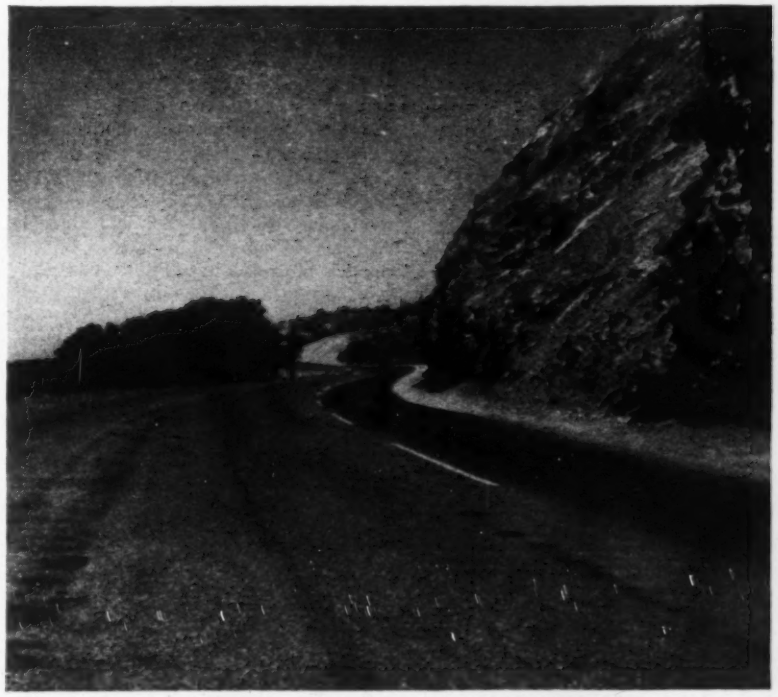
D. A. McKinnon, state highway engineer, states that the two most definite trends which have developed during the past season are: (1) the trend away from the use of light waterproofing seals without the use of stone cover material and toward the use of heavy armor coats using heavy asphalts and stone chips; (2) the trend toward the oil treating of the entire roadway section from shoulder edge to shoulder edge in order to prevent seepage of moisture into the roadway shoulders. [Details of practice will be given in a future article. Editor]. The figures for 1939 and 1940 follow:

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	None
Bituminous types (including surface treated stabilized bases)	136
Graded and drained (including gravel or other untreated mineral surfaces)	215
Total mileage constructed in 1939	351

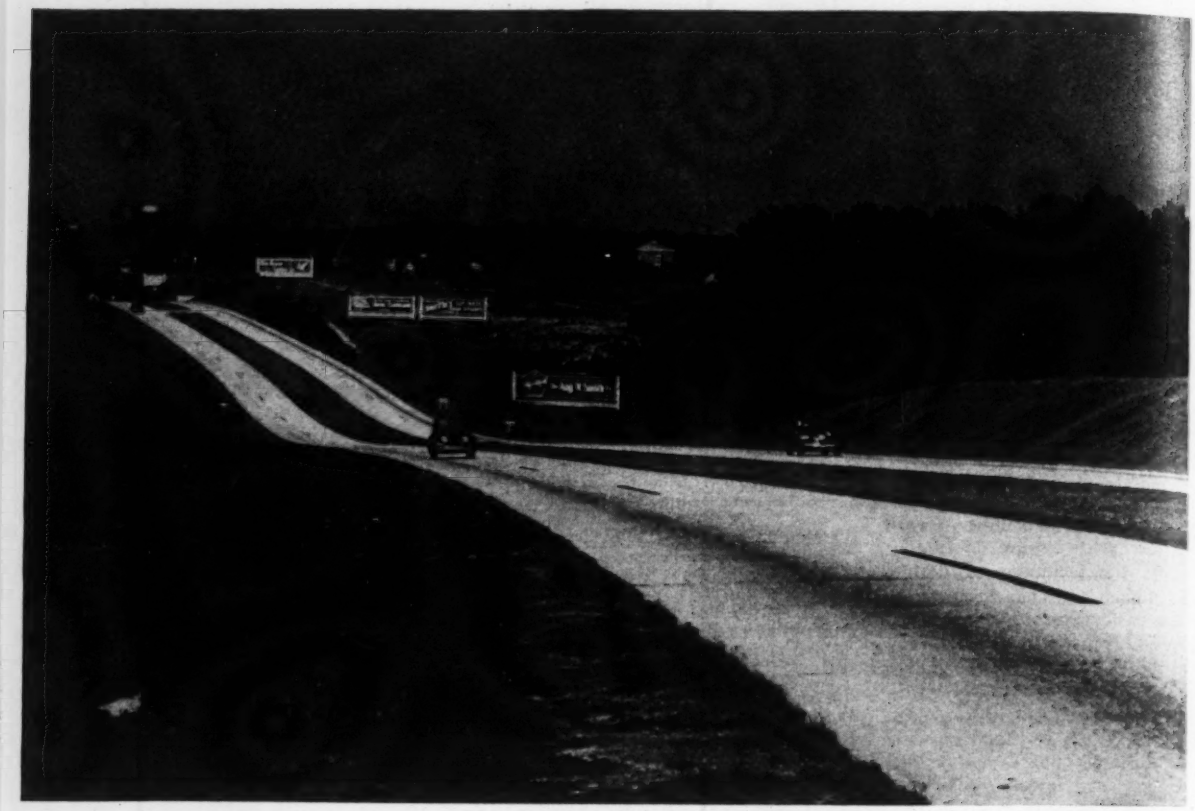
EXPENDITURES	Actual 1939	Estimated 1940
Construction	$6,200,000	$5,100,000
Maintenance	1,900,000	1,900,000
Equipment	200,000	200,000
Total	8,300,000	7,200,000

Oregon starts rebuilding

S. H. Probert, office engineer, states that Oregon has reached the point where new highway construction requirements are of less importance than the relocation and modernization of obsolete sections of trunk highways. The revenues, however, do not permit the rebuilding of many miles in any given year because of the excessive cost of constructing new roadbed in mountainous sections. A good start has been made in the building of the relocated water grade route for the



Arizona is widening existing roads and adding wide shoulders where that is possible.



Divided highways are rapidly reaching out from metropolitan areas into the real country as shown by this South Carolina example.

Columbia River Highway between Portland and Hood River. The estimated cost of the contemplated improvement of this entire section of the Columbia River Highway is nearly $8,000,000. Another major reconstruction project nearing completion is the Pacific Highway, between Ashland and the California state line.

The commission also faces the problem of relieving congestion on highway routes through cities. Excessive right-of-way costs hold back any extensive program of improvements in municipalities; however, the year 1940 will witness a continued activity in this field of highway improvement.

The road work of 1939 and that estimated for 1940 is as follows:

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	0
Bituminous types (including surface treated stabilized bases)	420
Graded and drained (including gravel or other untreated mineral surfaces)	420
Total mileage constructed in 1939	840

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$6,100,000	$6,500,000
Maintenance	3,400,000	3,850,000
Equipment	270,000	300,000
Total	9,770,000	10,650,000

Idaho develops soil analysis

Soil analysis and investigations have become one of the most important requirements in the design and control during construction of state roads. Greater care is being exercised and the specifications are becoming more stringent in selecting and using base and surfacing materials. State highway engineer H. R. Flint also reports increased maintenance costs due largely, it is believed, to increases in allowable truck loading. The 1929 legislature increased the gross load from 40,000 to 50,000 lb. and in 1937 another increase was made to 68,000 lb., and during this period maintenance costs have steadily grown. Mr. Flint gives the construction and expenditures for 1939 and 1940 as follows:

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	3.262
Bituminous types (including surface treated stabilized bases)	115.955
Graded and drained (including gravel or other untreated mineral surfaces)	78.484
Total mileage constructed in 1939	197.701
Surfacing only (crushed rock or crushed gravel)	43.792

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$3,900,000	$4,022,000
Maintenance	1,567,000	1,650,000
Equipment	101,000	100,000
Total	5,568,000	5,772,000

Nevada designs for safety

A planned policy to increase road safety by improved design has been followed during 1939 and is to be continued in 1940, reports C. V. Melarky, office engineer. Greater travel widths, more efficient methods of surface treatment, improved detours for handling traffic during construction, better signing along highways to aid drivers, elimination of short dangerous curves and increasing sight distances are developments expected in 1940. The construction figures for 1939 and 1940 are as follows:

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	0
Bituminous types (including surface treated stabilized bases)	149.03
Graded and drained (including gravel or other untreated mineral surfaces)	31.23
Total mileage constructed in 1939	180.26

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$2,800,000	$3,500,000
Maintenance	820,000	850,000
Equipment	50,000	50,000
Total	3,670,000	4,400,000

Washington advances heavy work

A continuation of the reconstruction of existing highway facilities to new location and design standards by widening, improving alignment, reducing gradients, subgrade reinforcement and the construction of bituminous surfaces is reported by L. V. Murrow, state highway engineer. Outstanding new highways were 4-lane highways between Vancouver and Olympia and between Lake Washington and North Bend. The entire section of the Paci-

fic Highway, between Olympia and Salmon Creek, a distance of 98 miles will be constructed on new alignment, a saving of distance of 17.72 miles.

The grading work on the approaches to the Lake Washington Pontoon Bridge between Factoria and Issaquah has been in full swing during the current year; paving will be undertaken early in the year 1940. The bridge is scheduled for completion about June 30, 1940. This new highway will provide a new four-lane paved route from Seattle to North Bend crossing Lake Washington over the pontoon bridge, which is being constructed by the Washington Toll Bridge Authority at an estimated cost of $8,780,000. The construction record for 1939 and 1940 is as follows:

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	13
Bituminous types (including surface treated stabilized bases)	677
Graded and drained (including gravel or other untreated mineral surfaces)	280
Total mileage constructed in 1939	970

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$7,342,000	$7,725,000
Maintenance	3,481,000	3,830,000
Equipment	276,000	275,000
Total	11,099,000	11,830,000

Utah straightens its roads

Obsolete alignment on sections of nearly every transcontinental route has been straightened to modern standards in 1939 and a continuation of this work is planned for 1940. The revisions involve heavy cuts and fills that reduce mileages and grades in nearly every operation. This information comes from E. C. Knowlton, state highway engineer, who also reports mileages and expenditures as follows:

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	12
Bituminous types (including surface treated stabilized bases)	226
Graded and drained (including gravel or other untreated mineral surfaces)	175
Total mileage constructed in 1939	413

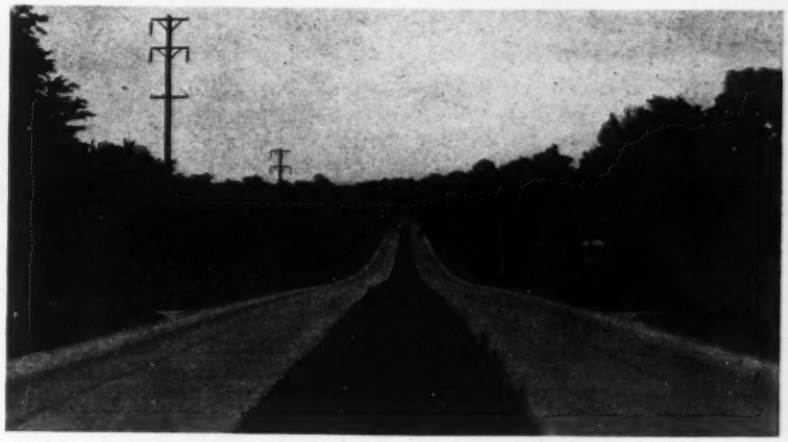
EXPENDITURES	Actual 1939*	Estimated 1940
Construction	$4,500,000	$3,800,000
Maintenance	1,250,000	1,500,000
Equipment	110,000	220,000
Total	5,860,000	5,520 000

* Subject to revision.

Arizona tries new technique

Developments in 1939 considered important by the highway department are given by W. R. Hutchins, state highway engineer, as follows: (1) the division of the state into 16 separate maintenance and construction districts with supervision of both maintenance and construction by competent engineers assigned to each district; (2) the use of open-graded plant mixes (grading, 100 per cent pass 1 in.; 85 to 100 per cent pass ¾ in., 20 to 55 per cent pas ⅜ in., 0 to 10 per cent pass No. 4) with 2C6 oil; (3) the study of oil mix failures due to lack of subgrade support and providing adequate base on new construction, based on field and laboratory studies of soils encountered. New developments in 1940 are the use

A characteristic road of the Far West, wide and straight, is represented by this Wyoming highway of 1939 construction for 100-mile speed.



Kentucky is putting the results of its highway survey into practice in its modernization of roads showing an increasing density of traffic.

Existing roads in Ohio are modernized by building a leveling course over half the old road to meet a median strip and then building an entirely new road on the opposite side of the strip, to the right in this view.

Reconstruction of the Pacific Highway in Oregon. The old road is seen in the lower right and above the new road on the far hill.

of SC type oils; the use of thin mixes (2-in. thickness) on adequate base; the use of imported borrow for fills, thus eliminating side borrow and reducing erosion hazard; and an effort to develop light-weight concrete from native volcanic cinders. Mileages and expenditures are as follows:

MILEAGE	Built in 1939
Hard surface (concrete)	9.2
Bituminous types (including surface treated stabilized bases)	215.4
Graded and drained (including gravel or other untreated mineral surfaces)	28.9
Total mileage constructed in 1939	253.5

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$4,665,999	$5,500,000
Maintenance	1,180,548	1,165,000
Equipment	250,000	250,000
Total	6,096,547	6,915,000

California plans for safety

Of many advances the following in particular are mentioned by C. H. Purcell, state highway engineer:

During the year the construction of multilane divided highways has demanded increased consideration. Relief from traffic congestion and the added safety of divided lanes afforded by this type of construction has created public demand for such improvement which is far greater than present or anticipated funds will permit. The provision of satisfactory illumination at intersections in order to make night driving safer is likewise rapidly becoming a standard feature. Probably the most outstanding phase of the California Division of Highways' administration during 1939 has been the expansion of the safety or traffic department.

For 1940 the California Division of Highways looks forward to many new developments. One phase of design in which expansion is anticipated will be the special attention given to the development of freeways leading to metropolitan sections in order to provide facilities into the heart of congested areas. It is anticipated that during the coming year greater consideration will be given to the protection of roadsides against the development of so-called ribbon cities along the highways in suburban areas. This problem is being met in California by the cooperation with local governing bodies in the enactment of adequate zoning ordinances and in the establishment of legal set-back distance. Following are the 1939 mileages by types:

Type	Miles
Grade and pavement	31.6
Grade and plant-mixed surface	121.4
Grade and road-mix surface	103.2
Grade and oiled gravel surface	92.9
Armor coat and retread surface	122.6
Penetration and seal coat surface	342.9
Grade and untreated gravel surface	12.6
Grading only	5.8
Dust oiling	313.6
Shoulder treatment	73.5
Bridges and grade separation No.	(111)

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$18,744,800	$18,083,000
*Maintenance	9,369,900	6,415,867
Equipment	750,000	533,333
Totals	$28,864,700	$25,031,000

* Includes maintenance and operation of San Francisco-Oakland Bay Bridge.

Colorado improves design

General design improvement, reported by W. M. Williams, director of publicity, includes continuation of the program of the past several years of building wider roadways and bridges, using construction features to reduce maintenance costs and including all possible safety features such as increased sight distances, easier horizontal curves and flatter surfaces. Important is the fact that these features have been incorporated in the highways built through Colorado's vast mountainous area, thus increasing the pleasure and safety of mountain driving. Only in rare cases do grades exceed 6 per cent. It is planned in 1940 to continue this program and carry on a moderate extension of 4-lane roadway development on principal highways out of Denver. Four-lane sections which have been built and which will be continued have an average 2-lane width of 22 ft., these lanes divided by an average 8-ft. width center strip. The figures for 1939 and 1940 are:

MILEAGE	Built in 1939
Hard surface (concrete, brick, block)	None
Bituminous types — road mix oil mat	630
Graded and drained (including gravel surfaces)	241
*Total mileage constructed in 1939	241

* Oiling is done by state highway oiling crews and is separate operation from road construction.

EXPENDITURES	Actual 1939	Estimated 1940
Construction	$7,950,000	$5,750,000
Maintenance	1,325,000	1,325,000
Equipment	175,000	175,000
Total	9,450,000	7,250,000

Coleman-DuPont highway south of Wilmington, Del. — an example of up-to-date highway construction.

A *quarter-century* OF HIGHWAY PROGRESS

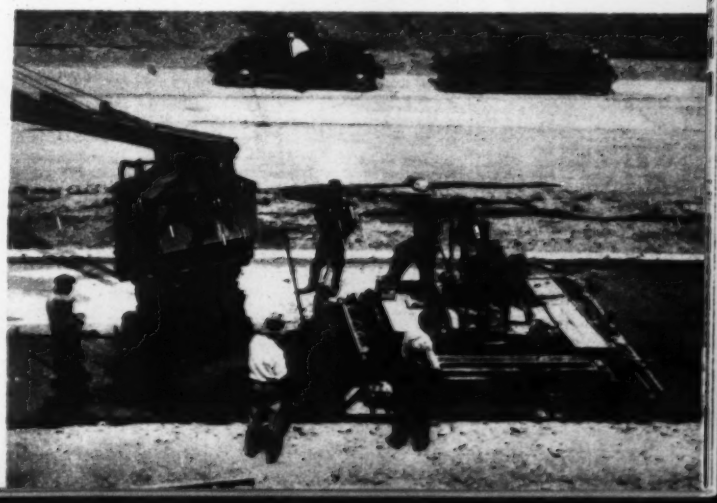
THE modern highway has developed to its present structural and construction standards in the last twenty-five years. In that time what has happened? An answer surpassing in clarity any possibility by narrative or description is given by the thirty-odd pictures that follow.

In contrast will be seen typical operations of roadbuilding as they are now performed and as they were performed in the second decade of the century. In twenty-five years machines have entirely changed roadbuilding processes.

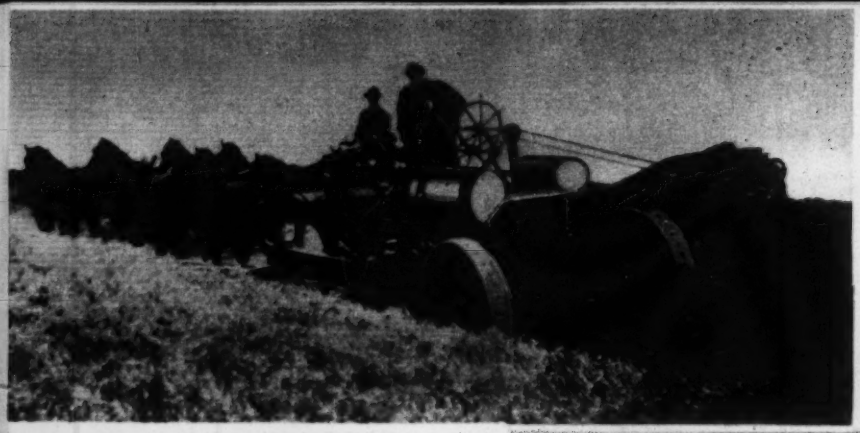
Road alignment, profile, surfaces and structures pictured as they are now and as they were a quarter of a century ago are as different as the machines used for road construction. In faster and smoother and pleasanter paths for motor vehicle travel highway engineers have in twenty-five years wrought one of the marvels of engineering in commercial transport.

And so that a vision of the task yet remaining to be performed may moderate pride and challenge further effort, these pictures show some of the things that have been badly done and that must be corrected and never done again.

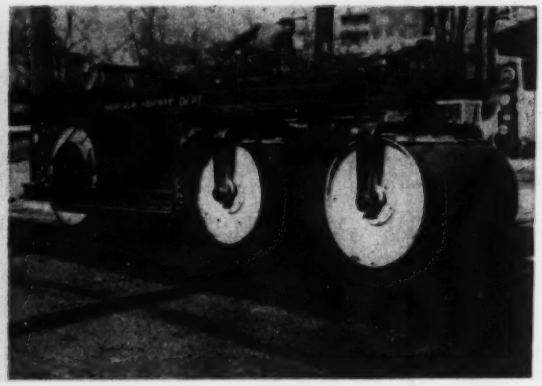
Modern machinery lays 1,000 ft. of roadway daily.



Progress in



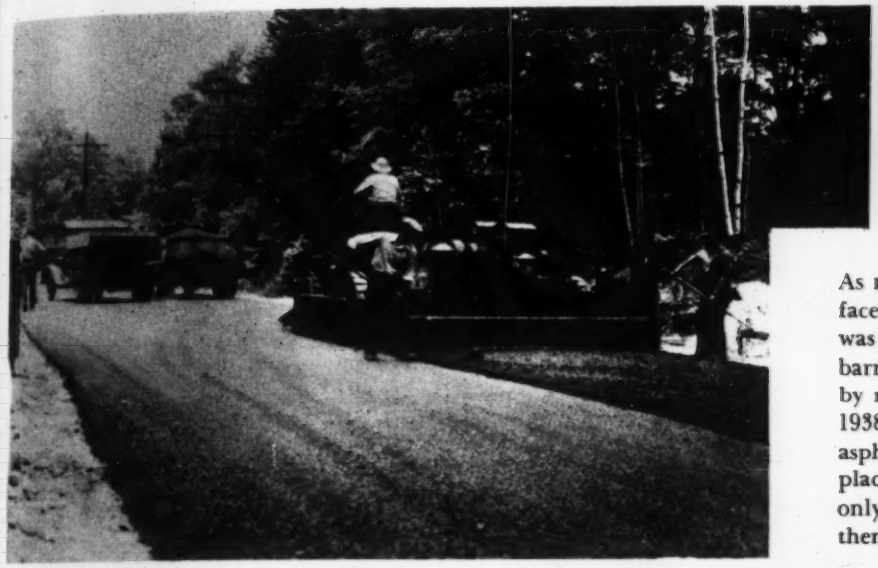
EXCEPT THE STEAM SHOVEL for deep cuts, the horse-drawn elevating grader (above) was the most pretentious and efficient mechanism for moving earth in the period from 1910 to 1920. Greatly improved, the power shovel and elevating grader continue as important grading tools, but tractors have replaced horses and the 12 to 30-yd. scraper (right) challenges older devices for efficiency.



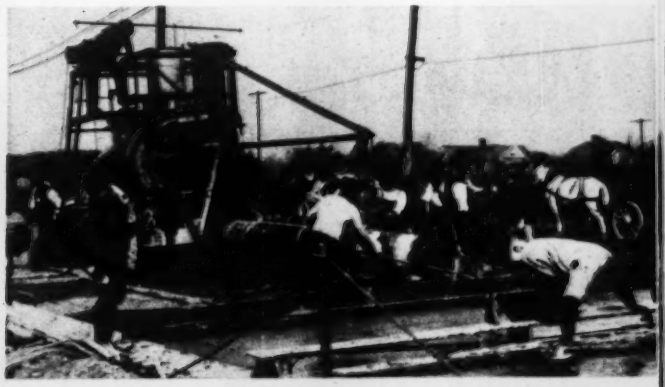
EVEN IN 1910, when this horse-drawn roller (extreme left) was working on a New Mexico highway, the ungainly steam roller developed in macadam roadbuilding was in common use. Working on a Pennsylvania road in 1938 the roller (right) exemplifies the latest advance in roller design – the middle roller that can be raised and lowered to iron out irregularities in the surface.

THE MAN with a "pouring pot" (above) was applying the bituminous seal coat on a Maine road being constructed in 1915. This "distributor" (right) working on a Virginia highway in 1937 exemplifies the modern pressure application of tar and asphalt in quantities controllable to tenths of a gallon per square yard.

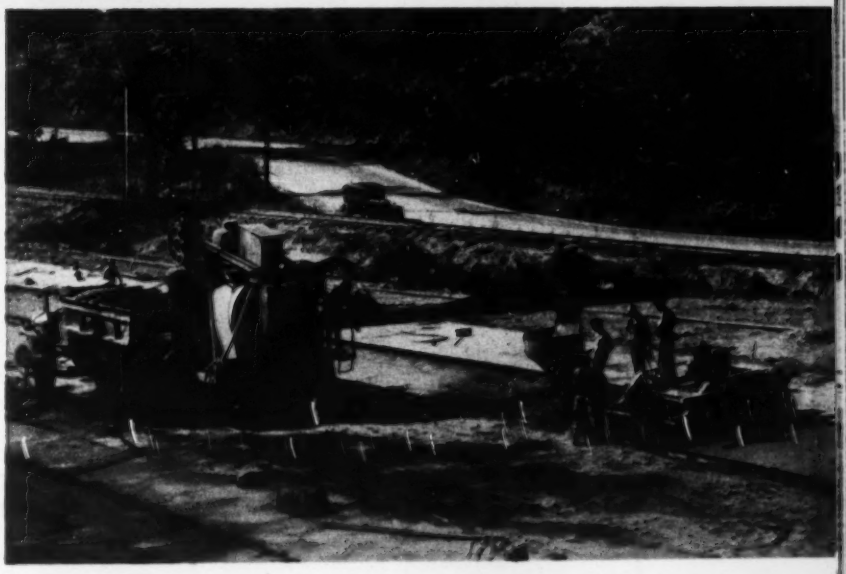
methods and machines



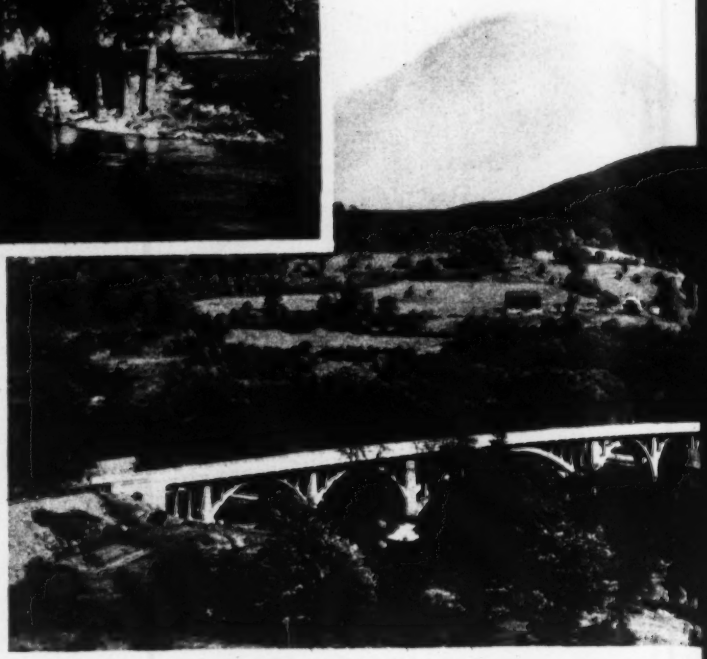
AS LATE AS 1921 asphaltic-concrete surface, as on the New Jersey road (above) was commonly distributed by wheelbarrows and smoothed to even surface by men with hand rakes. Now on this 1938 road (left), trucks dump the asphaltic mixture into a spreader which places it in an even layer that requires only an occasional stroke of a rake and then is ready for rolling.



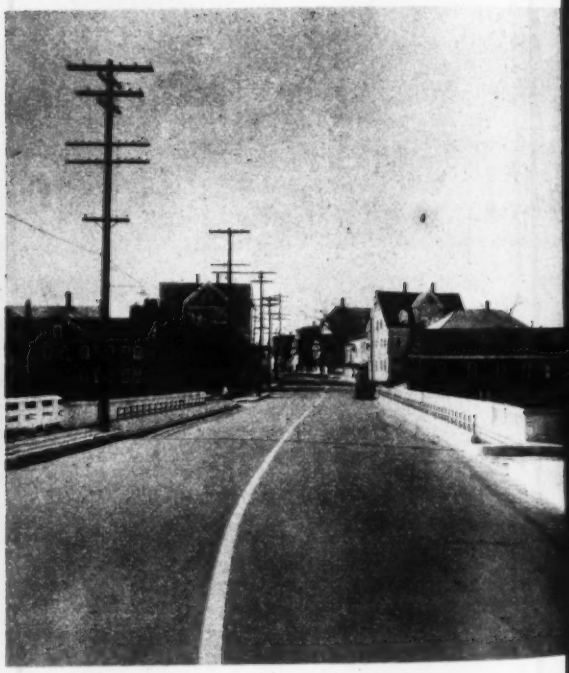
MEN WITH SHOVELS and wheelbarrows (upper left) loading sand and gravel into the hopper of a concrete mixer on concrete road construction in New Jersey in 1914; note the steam-powered mixer. A concrete so wet that it would flow (upper right) was used on this Maryland road in 1912, raked to even thickness, smoothed by a board templet and finished from a bridge by men with trowels; 200 ft. was a big day's work. Partitioned trucks (right), with each compartment holding a batch mechanically proportioned by weight at a central plant, charge the paving mixer on a four-lane concrete road in Virginia in 1937. The dry concrete is spread, vibrated and belted by machine at a rate of 1,000 ft. a day.



Progress i

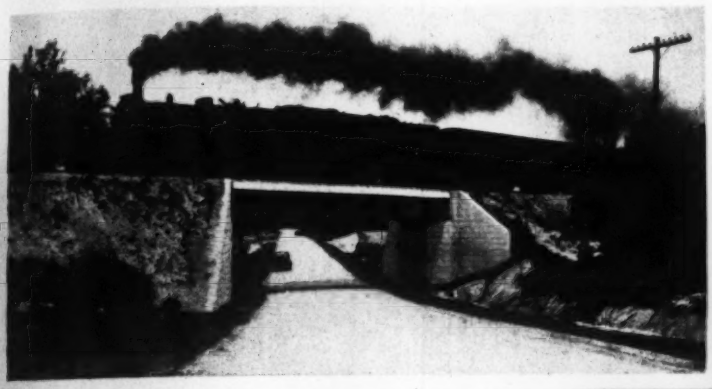


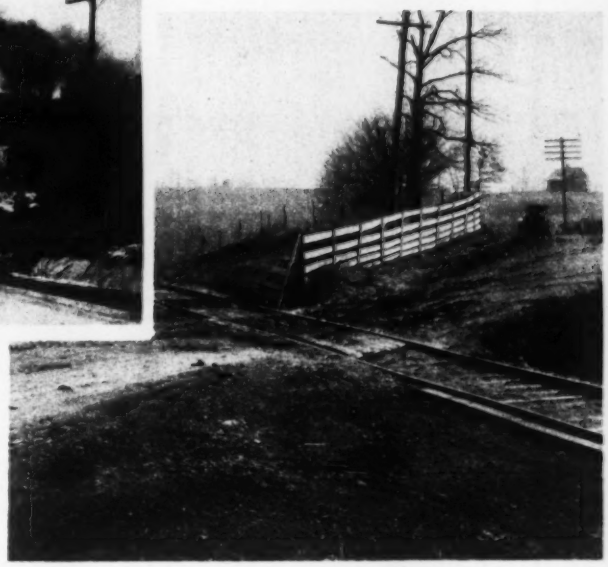
COVERED WOOD BRIDGES represent a bridge-building era that antedates the last quarter century, but they did service on many main roads twenty-five years ago as did the Cornwall bridge (above) in Connecticut. When the problem of better bridge service at Cornwall recently became pressing it was solved (right) by a rerouting and a structure that typifies modern road bridge practice in materials and design.



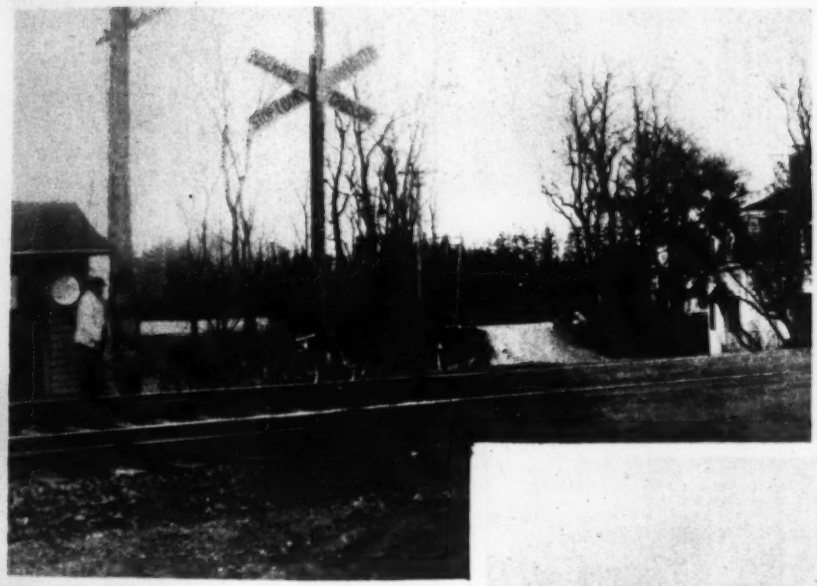
THE NATICK BRIDGE at West Warwick, R. I., located on a kink in the road, represents a condition that frequently existed when the photograph (left) was taken in 1914. The new Natick Bridge (right) photographed in 1939 shows the revolution wrought by modern road bridge design practice in appearance, roominess and road alignment.

ess in structures and roadway

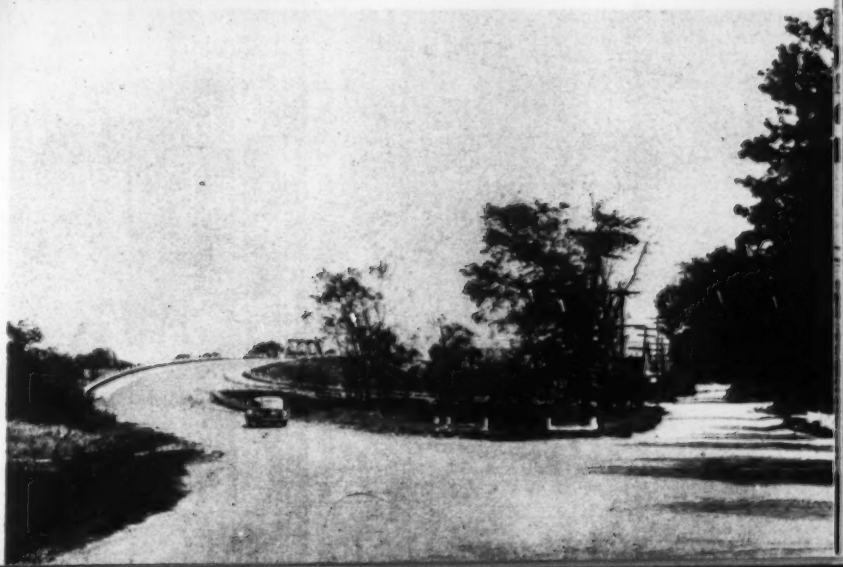




A RAILWAY GRADE CROSSING (right) on almost any road twenty-five years ago; this one happens to be in Tennessee and was photographed in 1918. Today hundreds of structures like this one (above), photographed in South Carolina in 1937, are replacing rural road and rail level crossings.



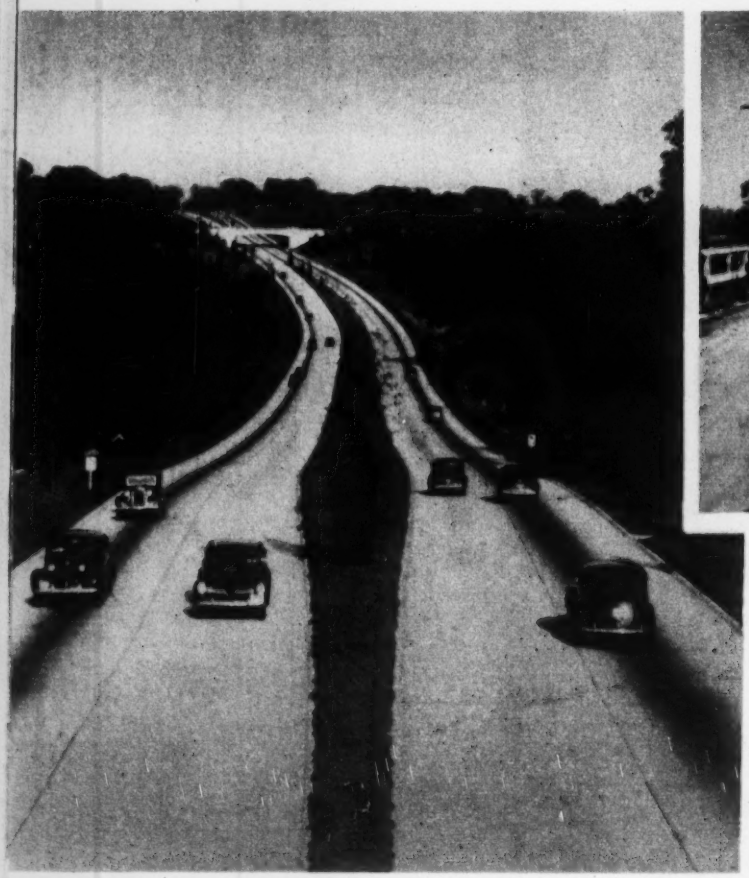
THIS CROSSING (left) at Davisville, R. I., photographed in 1914, is notable as indicating the range of the improvement work that engineers now undertake in order to remove hazard from a few yards of highway.



BEGINNING way back where the crossing road forks, (right) a new approach is designed to an overpass that removes all Davisville road traffic from crossing the railway at grade. The photograph was taken in 1939.

Progress in structures and roadway (continued)

IN 1914 (above) this was the Nooseneck Hill road in the township of West Greenwich, Rhode Island, a main road from Westerly to Providence and also for traffic east from New York along the Boston Post Road. A quarter of a century later in 1939 (right) the Nooseneck Hill road in West Greenwich is a four-lane road with concrete travel lanes and bituminous passing lanes.

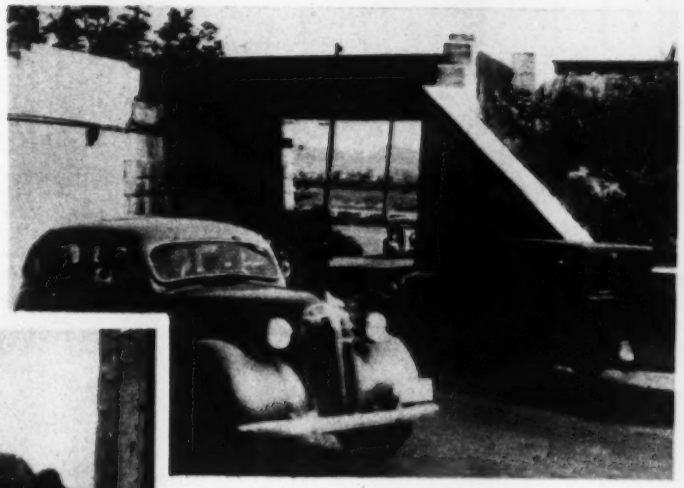


COUNTED A HEAVY TRAFFIC (500 to 1000 vehicles a day) road in 1911, Kings Highway (above) leading from New Haven, Conn., to New York was macadam with a bituminous surface treatment applied once a season to keep the dust down. Now the motorist making fast speed from New Haven, Conn., to New York travels the Merritt Parkway (left), a divided highway with two 18-ft. concrete lanes on each side of the median strip. In 1939 the traffic was about 19,000 vehicles a day.

Errors in the record

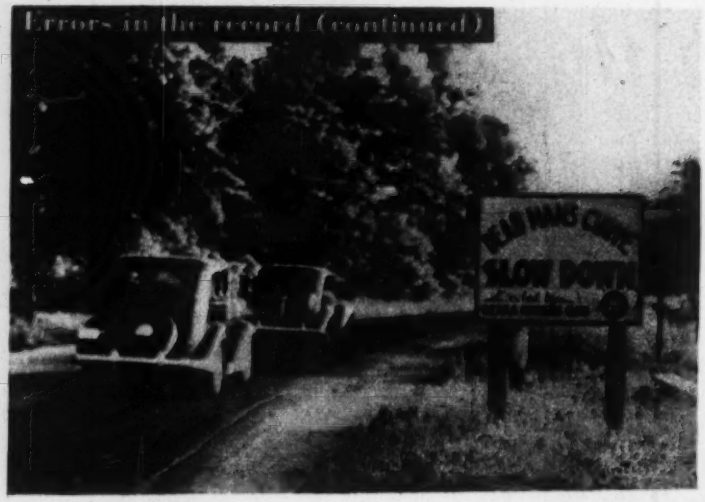
EVEN on heavily traveled main roads there are still many one-lane bridges to delay and endanger traffic, and here an approach curve increases the hazard.

HUGGING THE EDGES of the surfaced width two vehicles can get by on this road, which is a main road no narrower than many others; soft shoulders or speed are obvious threats.



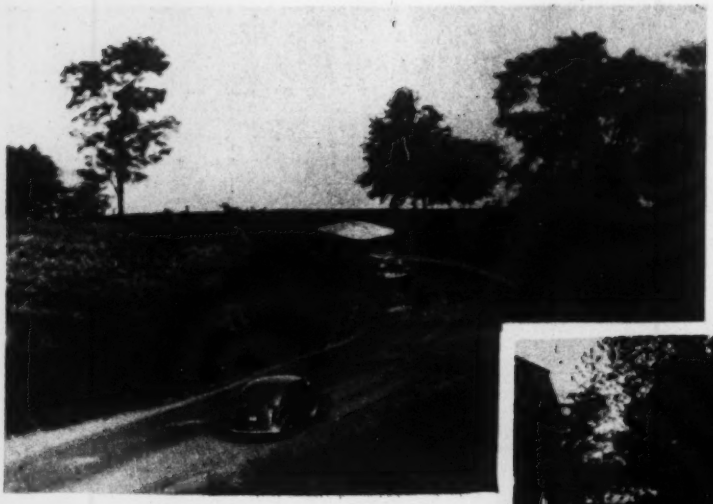
NARROW UNDERPASSES requiring right-angle turns or even worse approaches like this one exist on main roads in many towns, and are not lacking in open country.

A COMMON LOCATION fault has been to cling to old cow-path alignments of streets in villages and small settlements, with the result that situations like this are common.

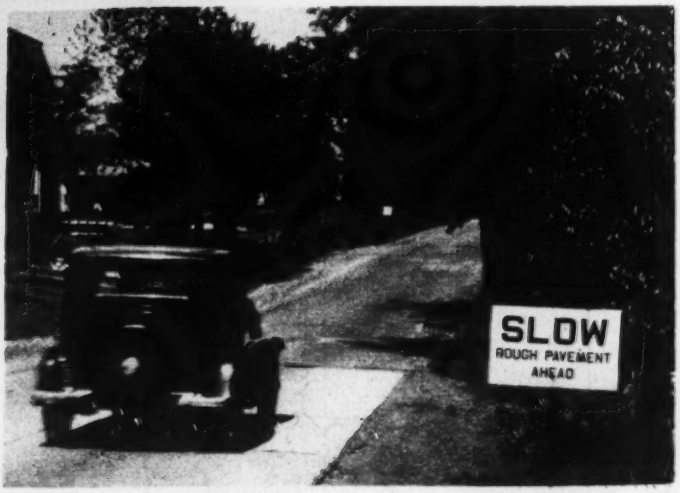


A DEAD-MAN'S CURVE is a location error commonly realized by the engineer and allowed to continue because the old road ran that way and new right of way increased costs.

AN EXPENSIVE ROAD paved to perfection, but that calls for a warning that danger threatens unless Fallston Hill is traveled at a creeping pace.



A CURVE NICELY BANKED but lacking in sight distance; here the hazard is increased since this is only one turn of a short S-curve.



A VILLAGE interposing its old paved street in the line of a highly improved state highway is a common interruption to free traffic flow.

THE SYMBOL OF MILES OF SMILES

Miles of roads constructed by Timken Bearing Equipped machines are "Miles of Smiles" for everyone concerned. For the construction contractor because he saves time and cuts costs . . . for the highway authorities because they are assured of long-lasting paving . . . for road users because they do not have to wait so long to enjoy the benefits of the new roads. Equipped with TIMKEN Bearings, modern road building and maintenance equipment like the Galion Motor Grader shown above operate faster, operate more economically, need less attention and stand up dependably no matter how tough the task.

When buying new equipment—power shovels, graders, concrete mixers, pavers, finishers, or any other kind of construction machinery—look for "Timken Bearing Equipped", the symbol for "Miles of Smiles".

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

SEE US AT THE ROAD SHOW
INTERNATIONAL AMPHITHEATER · CHICAGO
SPACE P-7

TIMKEN
TAPERED ROLLER BEARINGS

CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

ENLARGING RESERVOIR MASSACHUSETTS

OWNER: Metropolitan District Water Supply Commission, Commonwealth of Massachusetts, Boston. Karl R. Kennison, chief engineer.

PROJECT: Construction of two additional storage basins adjacent to and connecting with present Fells Reservoir, and appurtenant work necessary to increase storage capacity of existing reservoir. Work located in town of Stoneham and cities of Malden and Melrose, Mass.

CONDITIONS: Contractor to furnish all materials except 60-in. cast iron pipe, metalwork, and salvaged 16-in. cast iron drain pipe. Supply of water from reservoir must not be interrupted during construction. Roads to be provided for access to site of work. Work must be completed by June 15, 1940. Wage rates on project are: skilled, $1.25 to $1.62½ per hr.; semi-skilled, 75c. to $1.15; and common labor, 65c. per hr.

BIDS. Eleven bids were received December 21, 1939, ranging from the contract low of $132,395 to $197,185.

LOW BIDDERS:

1. Middlesex Constr. Co., Framingham, Mass. (contract) $132,395
2. J. F. Fitzgerald Constr. Co., Boston, Mass... 133,613
3. J. J. Callahan, West Roxbury, Mass..... 146,240

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Clearing	20 ac.	$480.00	$200.00	$100.00
2. Grubbing	10 ac.	90.00	300.00	100.00
3. Stripping	20,000 c.y.	.30	.40	.40
4. Earth excavation	7,000 c.y.	1.00	.50	.50
5. Rock excav., blasting	2,500 c.y.	2.40	2.00	4.00
6. Rock excav., no blasting	300 c.y.	12.00	7.00	8.00
7. Rolled imperv. embankmt.	40,000 c.y.	.40	.50	.42
8. Consol. pervious embankmt.	15,000 c.y.	.40	.31	.65
9. Soil dressing	1,500 c.y.	.80	.60	1.00
10. Seeding and grassing	2 ac.	150.00	400.00	160.00
11. Gravel surfacing, roads	2,500 c.y.	.85	.75	1.00
12. Cr. stone, screened grav	2,000 c.y.	1.90	3.50	1.75
13. Paving	60 c.y.	4.00	4.00	5.00
14. Riprap	3,500 c.y.	2.25	2.40	5.00
15. Cobble gutters	80 c.y.	4.00	6.00	2.50
16. Miscellaneous concrete	1,200 c.y.	6.00	7.00	8.50
17. Reinforced concrete	350 c.y.	12.00	13.20	13.00
18. Portland cement	6,000 bbl.	2.65	2.60	2.65
19. Reinforcing steel	50,000 lb.	.045	.04	.05
20. Misc. iron and steel	5,000 lb.	.10	.12	.15
21. Misc. non-ferrous metals	2,000 lb.	1.25	.45	1.10
22. C. I. pipe and fittings	60,000 lb.	.055	.05	.06
23. Misc. cast iron	40,000 lb.	.075	.07	.08
24. Galvanizing	3,000 lb.	.05	.03	.05
25. Prepare rock surfaces	2,000 s.y.	.30	.80	.10
26. Drill holes, rock and masonry	4,000 l.f.	.35	.50	.60
27. Placing grout	600 c.y.	5.60	8.00	4.00
28. Sand for grout	300 ton	1.50	2.00	1.00
29. Reservoir lining	500 s.y.	2.00	1.90	2.50
30. Stone masonry	15 c.y.	65.00	80.00	70.00
31. Boulder guard rail	1,000 bldrs.	1.00	1.00	1.00
32. Permanent fencing, type C	6,000 l.f.	1.40	1.40	1.60
33. Misc. lumber	5 M bm.	50.00	80.00	75.00
34. Lay 60-in. c.i. pipe	200 l.f.	10.00	5.00	5.60
35. Setting metal work	15,000 lb.	.03	.03	.02
36. Relay 16-in c.i dr. pipe	700 l.f.	2.50	2.00	.75
37. Valve and blow-off chambers	L.S.	150.00	300.00	600.00
38. Alter existing gate house	L.S.	150.00	558.00	2,300.00
39. Clean up	L.S.	500.00	1,000.00	500.00

JETTY REPAIRS, TEXAS

OWNER: U. S. Engineer Office, Galveston, Tex., Lt. Col. Frank S. Beeson, district engineer.

PROJECT: Consists of repairs to West Jetty and East Jetty at Sabine Pass, Texas. Repairs include filling voids between cover stones with core stones and capping jetties with concrete; and picking up and replacing existing cover stones and core stone.

CONDITIONS: Highway, rail and water transportation facilities available. Wages are: skilled labor, $1.00 per hr.; semi-skilled, 50c. per hr.; and common, 35c. per hr. Materials to be furnished by contractor.

BIDS: Six bids were received December 20, 1939, ranging from the contract low of $205,288 to $260,445. Engineer's estimate, $202,692.

LOW BIDDERS:

1. Brown & Root, Inc., Houston and Corpus Christi, Tex. (contract) $205,288
2. Chamberlain & Strain, San Antonio, Tex..... 210,105
3. Kansas City Bridge Co., Kansas City, Mo.... 237,360

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Core stone, type A	7375 ton	$7.45	$8.59	$8.00
2. Core stone, type B	950 ton	8.50	7.81	8.00
3. New cover stone	64 ton	9.60	10.00	8.00
4. Pick up and replace existing cover stone	50 pcs.	12.30	15.00	20.00
5. Concrete, West Jetty	5,250 c. y.	20.50	20.05	24.60
6. Concrete, East Jetty	1,630 c. y.	20.50	20.05	24.60

WATER SYSTEM, MONTANA

OWNER: City of St. Ignatius, Mont.; R. J. Hale, Missoula, Mont., engineer.

PROJECT: Constructing gravity type water system to take water from Mission Creek, 3 miles east of St. Ignatius. Includes intake diversion dam, pipes, fire hydrants, service connections, and storage tank.

CONDITIONS: Contractor to furnish all materials and complete job in 120 "weather-working" days. Severe winter weather may cause shut-down until spring. Rail facilities available to within 7 miles of site of work; highway transportation to site. Wage rates are: skilled, $1.20 per hr.; semi-skilled, 82c.; and common, 65c. per hr.

BIDS: Five bids were received ranging from contract low of $23,318 to $31,331. Awarded November 6, 1939.

LOW BIDDERS:

1. Federal Pipe & Tank Co., Seattle, Wash. (contract) $23,318
2. Union Construction Co., Great Falls, Mont.... 28,253
3. F. J. Mertz, St. Ignatius, Mont..... 29,070

Item	Quan.	Unit Prices (1)	(2)	(3)
1. 8-in. 50-ft. head wood pipe, incl. trench and backfill	5,800 l. f.	$0.795	$0.83	$0.85
2. 6-in. 50-ft. head wood pipe, incl. trench and backfill	4,000 l. f.	.615	.80	.82
3. 6-in. 100-ft. head wood pipe, incl. trench and backfill	4,700 l. f.	.63	.85	.90
4. 6-in. 200-ft. head wood pipe, incl. trench and backfill	1,250 l. f.	.68	.85	.90
5. 4-in. 200-ft. head wood pipe, incl. trench and backfill	12,500 l. f.	.543	.75	.75
6. 1-in. galv. iron pipe, trench and backfill	1,440 l. f.	.35	.45	.45
7. 8-in. gate valves, incl. box	2 ea.	60.00	49.00	50.00
8. 6-in. gate valves, incl. box	9 ea.	44.00	36.00	36.00
9. 4-in. gate valves, incl. box	11 ea.	31.00	22.00	20.00
10. 1-in. gate valves, incl. box	6 ea.	16.00	12.00	15.00
11. 4-in. fire hydrants, in place	14 ea.	92.50	80.00	85.00
12. 15-in. perf. and paved corr. iron pipe, in place	250 l. f.	4.00	5.00	6.00
13. 40,000-gal. wood stave tank, roof and foundation	L. S.	1,485.00	1,675.00	1,700.00
14. ¾-in. service connections	1 ea.	23.50	35.00	30.00
15. Float control (fixed price)	1 ea.	253.00	253.00	253.00
16. Structural excavation	225 c. y.	2.20	1.00	1.10
17. 2-in. stop and waste	3 ea.	45.00	30.00	25.00